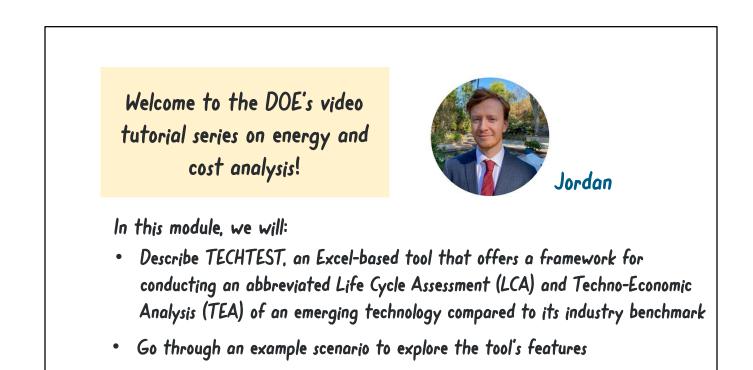


TECHTEST: An Excel-Based Tool for Evaluating Techno-Economic, Energy, and Carbon Impacts of Early-Stage Technologies A Tutorial from the U.S. Department of Energy

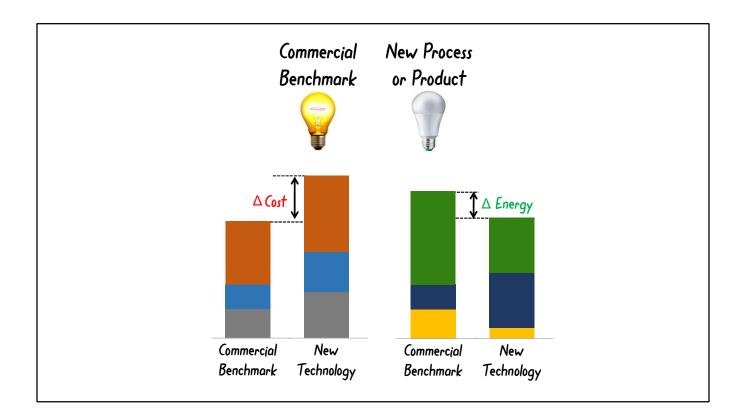


Welcome to the DOE video tutorial series on energy and cost analysis. In this module, we will:

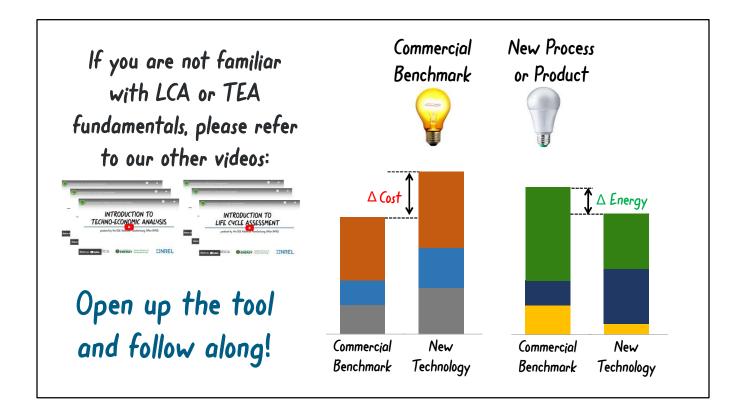
- Describe TECHTEST, an Excel-based tool that offers a framework for conducting an abbreviated Life Cycle Assessment and Techno-Economic Analysis of an emerging technology compared to its industry benchmark.
- We will also go through an example scenario to explore the tool's features.

The tool has been developed to clearly help demonstrate the benefits of an emerging technology

When provided with cost, energy, and emissions data for new and benchmark technologies, TECHTEST will generate summary tables and visualizations detailing the potential benefits and drawbacks resulting from deployment of the new technology. The tool has been developed to help clearly demonstrate the benefits of an emerging technology to potential investors as well as to state and federal funding agencies.



While working with TECHTEST, you will input data for a new process or product as well as for its analogous industry benchmark technology. TECHTEST will then generate comparative insights about the economic and environmental impacts of both technologies.



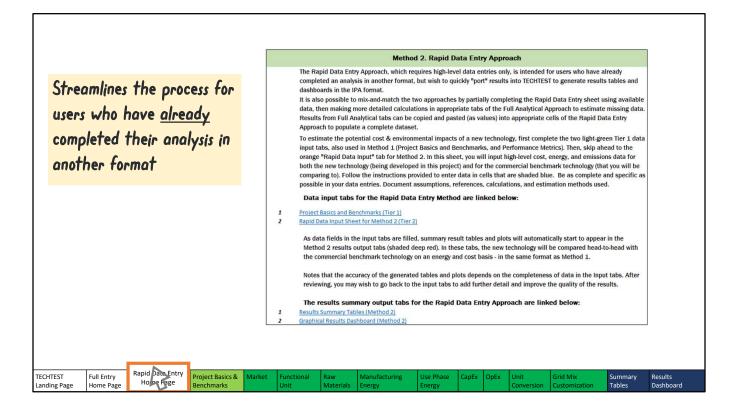
Note that if you are not yet familiar with Life Cycle Assessment and Techno-Economic Analysis fundamentals, please refer to our other tutorial videos in this series. Also, please note that TECHTEST only examines the Global Warming Potential impacts of the new product or process and does not incorporate other environmental factors. Before continuing, we encourage you to open up the tool itself and follow along to get a hands-on understanding of its required inputs and overall functionality.

U.S. DEPARTMENT OF ENERGY (DOE) OFFICE OF ENERG	Y EFFICIENCY AND RENEWABLE ENERGY (EERE) Ieuristic Tool for Early Stage Technologies (TECH)	TEST) ENERG	ĞŸ
Version 1.0 Release: February 19, 2023		Office of ENERGY EFFI RENEWABLE	- FICIENCY &
	al cost, energy, and emissions data about a new technology and the associ comparison. s that will project the economic and sustainable viability of the product con market technology.		
	There are two ways to fill out TECHTEST:		
•Full Analytical Approach: Review each se	tion of the lifecycle separately, enter more granular data. (Recommen	ded for first time users)	
Rapid Data Entry Approach: Abbreviat	ed approach, little to no explanation of steps. (Recommended for mul	tiple scenario testing)	
TEOLITEOT D			
sources can be found in the link below:	terials and energy sources to fill out the back end of the calculation. The calculation the calculation the calculation the calculation the calculation the calculation. The calculation the calculation the calculation the calculation the calculation the calculation.	ost vectors and correspondir	ing Backend data tab
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TECHTEST utilizes CO2-e and costs associated with ma sources can be found in the link below:	Link to energy/cost data tables. Link to global warming potential data tables LCA Tutorials TEA Tutorials	ost vectors and correspondin	Backend data tab

The TECHTEST tool starts with a few introductory tabs that contain helpful information. The TECHTEST Landing Page contains links to tutorial videos, and back-end data tables.

	Method 1. Full Analytical Approach				
	This method generates results from scratch, starting with source data. This is the recommended method for most users who are starting from scratch. If you are beginning with a complete cost, energy, and emissions analysis in another format and simply need to "port" data into the IPA template, you can consider the Rapid Data Entry Approach.				
	To estimate the potential cost & environmental impacts of a new technology, complete all green input tabs. You will input data for both the new technology (being developed in this project) and for the commercial benchmark technology (that you will be comparing to). Follow the instructions provided to enter data in cells that are shaded blue (text or numeric entry) or gold (dropdown menu selection). Be as complete and specific as possible in your data entries. Document assumptions, references, calculations, and estimation methods used.				
	It works best to complete tabs in order from left to right - but it is OK to fill them out of order, if needed. If filling tabs out-of-order, follow instructions carefully to enter certain data points in earlier tabs as needed, rather than over-writing formulae in the sheet. This will avoid problems with duplicate data entries, cell reference errors, and named variables.				
	Data should be entered ONLY in the blue and gold cells. Data input tabs for the Full Analytical Approach are linked below:				
	Data input tabs for the Full Analytical Approach are linked below:				
1	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1)	De	nta inout	t tobs	for
1 2 3	Data input tabs for the Full Analytical Approach are linked below:	Da	<mark>ita inpu</mark> t	t tabs :	for
2	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2)	Da	ita input	t tabs	for
2 3	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2) Functional Unit (Tier 2)	Da th	ita input e <u>Full A</u>	t tabs nalytic	for <u>al</u>
2 3 4	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2) Functional Unit (Tier 2) Raw Materials (Including: Embodied Energy, Emissions, and Costs (Tier 2))	Da th	ita input e <u>Full A</u>	t tabs nalytic	for <u>al</u>
2 3 4 5	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2) Functional Unit (Tier 2) Raw Materials (Including: Embodied Energy, Emissions, and Costs (Tier 2)) Manufacturing Energy (Manufacturing Phase Energy & Emissions (Tier 2))	Da th Aa	nta input e <u>Full A</u> poroach	t tabs nalytic	for <u>al</u>
2 3 4 5 6	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2) Functional Unit (Tier 2) Raw Materials (Including: Embodied Energy, Emissions, and Costs (Tier 2)) Manufacturing Energy (Manufacturing Phase Energy & Emissions (Tier 2)) Use Phase Energy (Energy andEmissions (Tier 2))	Da th <u>A</u> f	ita input e <u>Full A</u> oproach	t tabs nalytic	for <u>al</u>
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2 3 4 5 6 7 8	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2) Functional Unit (Tier 2) Raw Materials (Including: Embodied Energy, Emissions, and Costs (Tier 2)) Manufacturing Energy (Manufacturing Phase Energy & Emissions (Tier 2)) Use Phase Energy (Energy andEmissions (Tier 2)) Grid Mix CapEx (Tier 2) OpEx (Tier 2) As data fields in the input tabs are filled, summary result tables and plots will automatically start to appear in the two	Da th Ap	ita input e <u>Full A</u> oproach	t tabs nalytic	for <u>al</u>
2 3 4 5 6 7 8	Data input tabs for the Full Analytical Approach are linked below: Project Basics & Benchmarks (Tier 1) Market (Tier 2) Functional Unit (Tier 2) Raw Materials (Including: Embodied Energy, Emissions, and Costs (Tier 2)) Manufacturing Energy (Manufacturing Phase Energy & Emissions (Tier 2)) Use Phase Energy (Energy andEmissions (Tier 2)) Grid Mix CapEx (Tier 2) OpEx (Tier 2)	Da th Ag	ita input e <u>Full A</u> oproach	t tabs nalytic	for <u>al</u>

On the Full Entry Home Page tab, you will find a list of data input tabs for the Full Analytical Approach, which we'll be going through today.



There's also a Rapid Data Entry Home Page, which streamlines the process for users who have already completed their analysis in another format and are using TECHTEST to quickly generate results tables and visualizations.

		Method 1.	Full Analytical	Approach					ser input - text or		
	This method generates resu who are starting from scrato format and simply need to " To estimate the potential co input data for both the new (that you will be comparing numeric entry) or gold (drop Document assumptions, ref It works best to complete ta out-of-order, follow instructi formulae in the sheet. This Data should be entered ONI Data input tabs for the I	ch. If you are begin port" data into the technology (being to). Follow the inst down menu selecti erences, calculatio obs in order from le ions carefully to en will avoid problems .Y in the blue and g	ning with a compi IPA template, you al impacts of a ne developed in this ructions provided ion). Be as compl ons, and estimatic eff to right - but it ter certain data p s with duplicate d gold cells.	ete cost, ener, a can consider w technology, project) and fc to enter data ete and specif n methods use is OK to fill th oints in earlie ata entries, ce	gy, and emissions the Rapid Data f complete all gree or the commercia in cells that are s ic as possible in y ed. em out of order, i r tabs as needed,	a analysis in a Entry Approach en input tabs. I benchmark t shaded blue (t your data entr f needed. If fi rather than o	nother n. You will echnology ext or ies. lling tabs ver-writing	dropdown Purple Cells: EIA sector ave assumptions (more specific Other Cells:	User input-select f Default data based reges or standard can be user modified data are available) Not intended for edit Not pject Bas Se Cycle I onomic C	on I if	d:
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2	Market (Tier 2)							Lit	e Cycle I	mpact	<u>ک</u>
3	Functional Unit (Tier 2)							•	/		
4	Raw Materials (Including: Embe							٢.	anamia (ancida	- ations
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7	Grid Mix										
8	CapEx (Tier 2)										
9	OpEx (Tier 2)										
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		nology on an ener	gy and cost basis	After complet	ting all of the Inp	ut tabs, you ca	an scroll	_			
HTEST	Ful Entry Horoe Fage Home Page	Project Basics &	Market Function	al Raw	Manufacturing	Use Phase	CapEx OpEx	Unit	Grid Mix	Summary	Results

We'll be focusing on the Full Analytical Approach in this video. Throughout the tool, you will see blue, yellow, and purple cells: blue cells take text or numerical user input data; yellow cells will have you choose from a dropdown menu of options; and purple cells are filled with default data based on sector averages or standard assumptions (though these can be modified if more specific data are available). In this Full Analytical Approach, the data inputs required to generate results by TECHTEST fall into three categories: Project Basics, Life Cycle Impacts and Economic Considerations.

We'll start with a general overview of what's contained in each of these sections.

Return to Full Entry Home Page Return to Rapid Data Entry Home Page Returnation Project & Technology Description Project Title Waste Heat Recovery Cooling in Beverage Manufacturing Intervention Interventio	Return to Full Entry Home Page Return to Rapid Data Entry Home Page Project & Technology Description Project & Technology Description Project Title Waste Heat Recovery Cooling in Beverage Manufacturing Lead Organization Hypothetical Organization Collaborative Partner(s) Staff Principal Investigator Name John Doe Principal Investigator Organization Hypothetical National Laboratory AMO Technology Manager Jane Doe Project Start January-23 Project End January-25 Funding Mechanism R&D Project Define the generic market-end use product. If the new technology, commercial benchmark, other competing technologies produce different products that serve the same function and would be used in same market, the generic market end use product should be defined generally enough to encompass these different products or variations. For example, a Market End Use Product could be "automotiving strength steel" rather than the more specific "HSLA 350 steel produced by XYZ process." Defining a product and market that is too-specific may overly restrict the impact analysis.					
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Project Basics & Market Functional Grid Mix	ame function. Specific differences in the end pro					

There are four tabs that fall into the Project Basics category. These tabs help the user get started by describing the associated industry and fundamentals of the project.

	Definitions of Competing Technologies and Products				Technology De	finition	Specific Pro	duct or Application	Technology Status		
					Define the techno	logy.		d-use products and/or is for this technology, erences.	Is this technology a cur technology, a state-of-t technology, or an eme technology?	he-art	
		New Technology (developed	in this project)		Waste Heat Re Pump)	covery (Heat	Cooled Wast	e Water	Typical Technology		
		Commercial Benchmark Tec	nnology		Evaporative Co	ndenser	Cooled Wast	e Water	Typical Technology		
		Other Competing Technolog (list relevant technologies, s		nas)							
1	Energy, Emis	sions & Cost Impa	ct Drivers		Note:	This section	examines	emissions over	the <u>entire lifec</u>	<u>ycle</u> .	
		In your opinion, would this to energy and/or emissions			Yes/No		Mechanism (Explain why th		e likely to have an impac	r.)	
		raw materials used in the	manufacturing pro	cess?	No						
		manufacturing the end-us	e product?		Yes		Higher energy efficiency, no cooling water needed				
		using, transporting, or dis	posing of the end-	use product?	No						
L		In your opinion, would this to manufacturing costs asso		to impact the	Yes/No		Mechanism	1			
		capital equipment?			No						
	[raw materials used in mai	ufacturing?		No						
	1	energy used in manufactu	ring?		No						
		manufacturing labor?		6	No						
					~						
		In your opinion, would this to following <u>sectors</u> (energy, e			Yes/No		Mechanism	i			
	For each sector that would be impacted by	Mining			No						
	the new technology, briefly describe the mechanisms of potential impacts.	Manufacturing			Yes		Used to save	e energy in beverag	e manufacturing		
	(Assume successful commercialization and	Transportation			No						
	adoption.)	Energy Generation (utility sc	ale)		No						
					No						
		Enormy Constantion (device s	cale)		NO						

In the Project Basics & Benchmarks tab, the user identifies where energy, emissions, and cost improvements may occur with respect to the new technology.

Techno-economic, Energy 8	Carbon Heuristic I	ool for Early Stage Te	chilologies (TECHT	E31)	ENERGY
		Return to Planning Page			Office of ENERGY EFFICIENCY &
Market Size					RENEWABLE ENERGY
Quantify the total size of the end-use produc	t market. Provide calculations	and references at the bottom of th	e sheet.		
The end-use product should be defined in th	e Benchmarking section of the	Project Basics tab.			_
Annual U.S. Production of End-use Produc	t:	7,300,000 Million Gallons	of Cooled Waste Water	per year	_
	(all U.S. production, all facilit	ies) (units)			
If the new technology will NOT be deployed i		a naturation of the	, and use anodust suplain bala		_
In the new technology will NOT be deployed i	an existing market, or there is	s not yet any 0.5. production of the	end-use product, explain belo	w.	1
Comment	s:				
Market Breakdown					
Estimate the percent market share for the n	ew technology, the commercia	I benchmark, and other competing	g technologies:		
Estimate the percent market share for the n	-		g technologies:		
	te the market breakdown base	ed on the current U.S. market.	-	echnology is fully deploy	ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estima	te the market breakdown base ate the market breakdown in a	ed on the current U.S. market.	-	echnology is fully deploy	ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estima - In the "Overnight Adoption" column, estima conditions remain the same as the current t	te the market breakdown base ate the market breakdown in a .S. market.	ed on the current U.S. market.	-	echnology is fully deploy	ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estim - In the "Overnight Adoption" column, estim	te the market breakdown base ate the market breakdown in a .S. market.	ed on the current U.S. market.	-	echnology is fully deploy	ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estima - In the "Overnight Adoption" column, estima conditions remain the same as the current t	te the market breakdown base ate the market breakdown in a .S. market.	ed on the current U.S. market.	-	chnology is fully deploy Full Deployment	ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estima - In the "Overnight Adoption" column, estima conditions remain the same as the current t	te the market breakdown base ate the market breakdown in a .S. market.	ed on the current U.S. market. hypothetical "overnight adoption"	marketplace where the new te		ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estima - In the "Overnight Adoption" column, estima conditions remain the same as the current t	te the market breakdown base ate the market breakdown in a .5. market. Id sum to 100%.	ed on the current U.S. market. hypothetical "overnight adoption" Product /	marketplace where the new te	Full Deployment	ed, but all other market
Estimate the percent market share for the n - In the "Current Conditions" column, estima - In the "Overnight Adoption" column, estima conditions remain the same as the current t	te the market breakdown base ate the market breakdown in a .S. market.	ed on the current U.S. market. hypothetical "overnight adoption"	marketplace where the new te	Full Deployment	ed, but all other ma
Estimate the percent market share for the n - In the "Current Conditions" column, estime - In the "Overnight Adoption" column, estim conditions remain the same as the current t	te the market breakdown base ate the market breakdown in a .S. market.	ed on the current U.S. market. hypothetical "overnight adoption"	marketplace where the new te	Full Deployment Market Share (%):	ed, but all other market

The Market tab collects information on the projected market size...

	Annual U.S. Production of End-use P		II U.S. production, all facili		Million Gallons (units)	of Cooled Waste				
		(ca	in o.o. production, an racin	ilico)	(units)					
lf ti	the new technology will NOT be deplo	oyed in an	existing market, or there	is not yet any U.S	5. production of the er	d-use product, expla	ain below.			
	Com	nments:								
M	larket Breakdown									
Eat	timate the percent market share for	the new to	a shualage the commonic	al hanahmark, av	ad other competing to	abualagiaa				
ESI	annate the percent market share for	the new te	echnology, the commercia	ai Delicimark, ai	id other competing te	chilologies:				
	In the "Current Conditions" column, e									
	In the "Overnight Adoption" column, e			a hypothetical "o	vernight adoption" ma	arketplace where the	e new techno	logy is fully deploye	ed, but all other market	t)
cor	nditions remain the same as the cur	rent 0.5. n	narket.							
The	e total market share in each column	should su	ım to 100%.							
		_					r		1	
						Pre-Deployme	ent Fu	II Deployment		
					Dendust (Pre-Deployme	Ma	arket Share (%):		
		Те	echnology*		Product /	Pre-Deployme	Ma "T	arket Share (%): arget Potential		
		Те	echnology*		Product / Application*:		Ma "T	arket Share (%):		
		Те	echnology*			Pre-Deployme Market Share (Current Conditio	Ma "T !%):	arket Share (%): arget Potential Market at Full		
	New Tech	W	echnology★ aste Heat Recovery (Heat	t Pump)		Market Share (Ma "T !%):	arket Share (%): arget Potential Market at Full Deployment"		
	New Tech Commercial Benc	nology: W		t Pump)	Application*:	Market Share (Current Condition	Ma "T !%):	arket Share (%): arget Potential Market at Full Deployment" othetical Scenario		
		nnology: ^{Wa} chmark: ^{Ev}	aste Heat Recovery (Heat	t Pump) 0	Application*: Cooled Waste Water Cooled Waste Water	Market Share (Current Conditie 0%	Ma "T !%):	arket Share (%): arget Potential Market at Full Deployment" othetical Scenario 100%		
	Commercial Benc	nnology: ^{Wa} chmark: ^{Ev}	aste Heat Recovery (Heat		Application*: Cooled Waste Water Cooled Waste Water	Market Share (Current Conditi 0%	Ma "T !%):	arket Share (%): arget Potential Market at Full Deployment" othetical Scenario 100%		
	Commercial Benc	nnology: ^{Wa} chmark: ^{Ev}	aste Heat Recovery (Heat		Application*: Cooled Waste Water Cooled Waste Water O	Market Share (Current Condition 0%	Ma "T !%):	arket Share (%): arget Potential Market at Full Deployment" othetical Scenario 100% 0%		
N	Commercial Benc	nnology: W chmark: Ev ologies:	aste Heat Recovery (Heat	0	Application: Cooled Waste Water Cooled Waste Water 0 Sum:	Market Share (Current Condition 0% 100%	Ma "T s): ons Hypo	arket Share (%): arget Potential Warket at Full Deployment" thetical Scenario 100% 0% 100%	led, please modify the	
	Commercial Benc	nnology: W chmark: Ev ologies:	aste Heat Recovery (Heat	0	Application*: Cooled Waste Water Cooled Waste Water 0 Sum:	Market Share (Current Condition 0% 100%	Ma "T s): ons Hypo	arket Share (%): arget Potential Warket at Full Deployment" thetical Scenario 100% 0% 100%	ied, please modify the	
	Commercial Benc Other Competing Techno Note that the technology and product	nnology: W chmark: Ev ologies:	aste Heat Recovery (Heat	0	Application*: Cooled Waste Water Cooled Waste Water 0 Sum:	Market Share (Current Condition 0% 100%	Ma "T s): ons Hypo	arket Share (%): arget Potential Warket at Full Deployment" thetical Scenario 100% 0% 100%	led, please modify the	
	Commercial Benc Other Competing Techno Note that the technology and product finitions in that tab.	nnology: W hmark: Ev ologies: definitions	aste Heat Recovery (Heat	0 Benchmarking se	Application*: Cooled Waste Water Cooled Waste Water 0 Sum: cotion of the "Project E	Market Share (Current Condition 0% 100%	Ma "T s): ons Hypo	arket Share (%): arget Potential Market at Full Deployment" othetical Scenario 100% 0% 100% efinitions are need		Results

...and market share of the two technologies.

Fu	unctional Units and Reference Quantities								
						10		Office of ENERGY	EFFICIENCY &
			Planning Page					RENEWA	BLE ENERGY
	An explanation of best practices for https://w				In DOE's "Functional C J.S.DepartmentofEnergy	Jnits" short tute	rial video:		Ľ
	A Functional Unit defines the quantity of a product or product system based on the environmental or cost metrics) for disparate products or systems that serve the same fit			used to object					
	Describing the f	final function	for the technol	ogy and de	fining the functiona	ıl unit.			
-							Examples		
	-If the technology is a production method, you can define the functional unit based on a For Example: A steel smelting process could be defined based on its ability it			s.			t required to produce 1		
								or an average mid-size sedar ness over 100,000 hours.	n.
	 If the technology is a product, you can define the functional unit based on a quantitative me For Example: A light source could be defined based on its ability to produce 1.00 			uct.				a dynamic load rating of 5.0	000 lbs.
_	Step 1: Based on the functional unit, specify a reference qua	E	Benchmark Tec	hnology.	be compared to an		erence quantit	y for the Commerc	ial
	oae the functional difference	specify a production	interence quantity i	or the new tec	noiogi, as shown in the exam	inpresidentity.			
	Functional Unit Based Reference Quantity for the New Technology:	2	Million Gallor	is of	Cooled Waste Water	for New Tech	ology		
		/alue	Unit		of Product				
	E	Examples:	80 kg of new ethylene						
			1,000,000 lumen-hou 9 kg of dual-phase hig		new LED bulb				
			18 recycled polymer p		llets in novel design				
Fin	inally, specific the performance-equivalent production reference quantity for the commercia depends on how you've defined your fun							quantity for the new tech	nology. It
	Performance Equivalent Reference Quantity for the Commercial Benchmark:	2 /alue	Million Gallor Unit	is of	Cooled Waste Water of Product	for Commerci	al Benchmark Technol	vgy	

The Functional Unit tab specifies the reference quantity for the new technology as well as a performance-equivalent reference quantity for the benchmark technology. The reference quantity specifies the amount of product delivered based on the performance of each technology.

Techno-econo	mic, Energy	& Carbon Heuris	stic Tool fo	or Early Stage Techno	ologies (TECHTEST)						ENERGY	
Grid Mix Custo	mization			Return to Planning Page							Office of ENERGY EFFICIENC RENEWABLE ENER	Y&
On this page, you can is an estimation o	n customize the gr of the percentage c	of various energy source	es used to creat		he TECHTEST tool. The specific 22 current US grid mix is the d rid Mix" dropdown menu.	Onu with	Blue Cells: User in numerical Yellow Cells: User dropdown Purple Cells: Defi ElA sector average assumptions (can b more specific data Other Cells: Not in	input - select from ult data based on o or standard e user modified if are available)				
Choose Grid Mix select from dropdown)	2022 Default								ustom Value Se			
			Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu				(Only use	for selecting cus	Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu	
lectricity Generation Te	echnology			emissions (Ib CO2-eq/MMBtu electricity generated) based on	Default CO2-eg/MMBtu data		Electricity Generati		for selecting cus		Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu electricity generated) based on	
	echnology Fossil Fuels	Coal	Total 21.9%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36	Default CO2-eq/MMBtu data 234.36		Electricity Generati Electricity Generati	on Technology	for selecting cus	Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36	
ectricity Generation		Coal Petroleum	Total 21.9% 0.5%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36 177.08	234.36 177.08			on Technology		Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/IMMBtu electricity generated) based on IPCC data 234.36 177.08	
ectricity Generation			Total 21.9% 0.5% 38.3%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36 177.08 130.62	234.36 177.08 130.62		Electricity Generation	on Technology	Coal	Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36 177.08 130.62	
lectricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases	Total 21.9% 0.5% 38.3% 0.3%	emissions (Ib CO2-eq/IMMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13	234.36 177.08 130.62 127.13		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases	Fraction of	Life-Ocle Electricity generation emissions (Ib CO2-eq/IMMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13	
lectricity Generation		Petroleum Natural Gas Other Gases Nuclear	Total 21.9% 0.5% 38.3% 0.3% 18.9%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13 7.76	234.36 177.08 130.62 127.13 7.76		Electricity Generation	on Technology	Coal Petroleum Natural Gas Other Gases Nuclear	Fraction of	Life-Cycle Electricity generation emissions (Ib CO2 eq:/MMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13 7.76	
lectricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3%	emissions (Ib C02-eq/IMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13 7.76 15.52	234.36 177.08 130.62 127.13 7.76 15.52		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower	Fraction of	Life-Orde Electricity generation emissions (Ib O2-eq./MMBtu electricity generated) based on IPOC data 1270 data 130.62 127.13 7.76 15.52	
lectricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3% 0.9%	emissions (Ib C02-eq/MMBtu electricity generated) based on IPCC data 130.62 127.13 7.76 1552 148.75	23436 177.08 130.62 127.13 7.76 15.52 148.75		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood	Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/IMBtu electricity generated) based on IPCC data 137.08 130.62 122.13 7.7.6 1552 148.75	
ectricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste	Total 21.9% 0.5% 0.383% 0.3% 18.9% 6.3% 0.9% 0.5%	emissions (b CO2-eq/MMBtu electricity generated) based on IPCC data 1270.08 1270.08 1270.08 1270.08 1270.08 1270.08 1270.08 1270.08 1270.08 1280.08 148.75 148.75	234.36 1177.08 130.62 127.13 7.76 1552 148.75 148.75		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Wood	Fraction of	Life-Oycle Electricity generation emissions (Ib CO2-eq/IMBtu electricity generated) based on IPOC data 130.62 127.13 127.13 15.52 148.75 148.75	
lectricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal	Total 21.9% 0.5% 38.3% 0.3% 6.3% 0.9% 0.5% 0.4%	emissions (Ib CO2-eq: MMBtu electricity generated) based on IPCC data 127 04 130 62 127 13 130 62 127 13 130 62 127 13 130 62 127 13 130 62 127 13 130 62 127 13 130 62 137 62 13	23436 177.08 130.62 127.13 7.76 15.52 148.75 148.75 24.58		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal	Fraction of	Life-Cycle Electricity generation emissions (Ib CO2-eq/IMIBtu electricity generated) based on IPCC data 234.36 137.76 130.62 127.13 7.76 148.75 148.75 24.58	
lectricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal Solar	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3% 0.9% 0.5% 0.4% 2.8%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 1370.62 1277.08 139.62 1277.13 7.76 15.52 148.75 148.75 24.58 3.104	23436 177.08 130.62 127.13 7.76 1552 148.75 148.75 2458 31.04		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Waste Geothermal Solar	Fraction of	Life-Cycle Electricity generation emissions (Ib CC2-eq/IMBtu electricity generated) based on IPCC data 130.62 132.13 7.7.6 155.2 148.75 148.75 2458 31.04	
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3% 0.9% 0.5% 0.4% 2.8% 9.2%	emissions (Ib CO2-eq/ MMBtu electricity generated) based on IPCC data 1270.08	23436 177.08 130.62 127.13 7.76 15.52 148.75 148.75 24.58		Electricity Generation	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal	Fraction of Total	Life-Oycle Electricity generation emissions (Ib CO2-eq/IMBtu electricity generated) based on IPOC data 130.62 127.13 7.76 115.52 148.75 24.58 31.04 7.11	
Electricity Generation Tr Electricity Generation fechnologies	Fossil Fuels Renewables	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Woo	Total 21.9% 0.5% 38.3% 0.3% 6.3% 0.9% 0.5% 0.5% 0.4% 2.8% 9.2% 100.0%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 1777.08 130.62 1277.13 7.76 1552 148.75 24.58 3.104 7.11	23436 177.08 130.62 127.13 7.76 1552 148.75 148.75 2458 31.04		Electricity Generati Technologies	on Technology on Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Wood Biomas - Wo	Fraction of Total	Life-Cycle Electricity generation emissions (Ib CC2-eq/IMBu) electricity generated) based on IPCC data 130 62 131 662 132 7.76 1552 148.75 148.75 2458 31.04 7.11	

Additionally, further to the right in the tab menu is the Grid Mix Customization tab, which allows you to choose between various default scenarios for the mix of electricity generation technologies...

Techno-econ	omic, Ener	gy & Carbon He	uristic Tool f	or Early Stage Techn	ologies (TECHTEST)							ENERGY	
				Return to Planning Page								Office of ENERGY EFFICIE RENEWABLE EN	NCY &
is an estimation	can customize th 1 of the percenta	ge of various energy so	ources used to creat	ricity generation emissions in te powerline electricity. The 2 e selected using the "Choose (022 current US grid mix is the	ic Grid Mix default. Eli as m	lue Cells: User inp umerical ellow Cells: User i ropdown urple Cells: Defau (A sector averages assumptions (can be hore specific data ar ther Cells: Not inte	nput - select from It data based on or standard user modified if re available)				RENEWABLE EN	ERGY
Choose Grid Mix (select from dropdow	2022 Det	ault							ustom Value Se			-	ן ן
Electricity Conception	Tochnolom		Fraction of Total	Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu electricity generated) based on IBCC data	Default CO2 og/MMPtu data		actually Consulting		for selecting cu	Fraction of Total	Life-Cycle E emissions (electricity g	lectricity generation Ib CO2-eq/MMBtu enerated) based of	
		Coal		emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data	Default CO2-eq/MMBtu data 234.36		ectricity Generation	1 Technology	for selecting cus	Fraction of	Life-Cycle E emissions (Ib CO2-eq/MMBtu	n
Electricity Generation		Coal Petroleum	Total	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data	234.30	Ele		1 Technology	_	Fraction of	Life-Cycle E emissions (electricity g	Ib CO2-eq/MMBtu enerated) based of	n 6
Electricity Generation			Total 21.9% 0.5% 38.3%	emissions (Ib CO2-eq/IMMBtu electricity generated) based on IPCC data 234.36 177.08 130.62	234.36 177.08 130.62	Ele	ectricity Generation	1 Technology	Coal	Fraction of	Life-Cycle E emissions (electricity g	Ib C02-eq/MMBtu enerated) based of 234.30 177.00 130.6	n 6 8 2
Electricity Generation		Petroleum	Total 21.9% 0.5% 38.3% 0.3%	emissions (Ib C02-eq/MMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13	234.36 177.08 130.62 127.13	Ele	ectricity Generation	1 Technology	Coal Petroleum	Fraction of	Life-Cycle E emissions (electricity g	Ib C02-eq/MMBtu enerated) based of 234.30 177.00 130.60 127.10	n 6823
Electricity Generation		Petroleum Natural Gas	Total 21.9% 0.5% 38.3% 0.3% 18.9%	emissions (Ib C02-eq/MMBtu electricity generated) based on IPCC data IPCC data 127.08 130.62 127.13 7.76	234.36 177.08 130.62 127.13 7.76	Ele	ectricity Generation	1 Technology	Coal Petroleum Natural Gas	Fraction of	Life-Cycle E emissions (electricity g	Ib CO2-eq/MMBtu enerated) based or 234.30 177.00 130.60 127.10 7.70	n 6 8 2 3 6
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36 177.08 130.62 127.13 7.76 15.52	234.36 177.08 130.62 127.13 7.76 15.52	Ele	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases	Fraction of	Life-Cycle E emissions (electricity g	Ib CO2-eq/MMBtu enerated) based or 234.30 177.00 130.6 127.1 7.70 15.5	n 6 8 2 3 6 2
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3% 10.9%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 234.36 130.62 130.62 127.13 7.76 1552 148.75	234.36 177.06 130.62 127.13 7.76 15.52 148.75	Ele	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear	Fraction of	Life-Cycle E emissions (electricity g	lb CO2-eq/MMBtu enerated) based of 234.30 177.00 130.60 127.10 7.70 15.50 148.79	n 682362
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3% 1 0.9% e 0.5%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 127.03 130.62 127.13 137.75 1552 148.75 148.75	234.36 177.06 130.62 127.13 7.76 1552 148.75 148.75	Ele	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower	Fraction of	Life-Cycle E emissions (electricity g	lb CO2-eq/MMBtu enerated) based of 234.30 177.00 130.60 127.11 7.70 15.55 148.70 148.70	n 682336255
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood	Total 21.9% 0.5% 38.3% 0.3% 6.3% 0.3% 0.9% 0.9% 0.0% 0.4%	emisions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 127.08 1127.08 1127.08 125.52 148.75 148.75 148.75 24.56 24.56	234.30 177.06 130.62 147.13 7.70 15.55 148.75 148.75 24.56 24.56	Ele Te	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood	Fraction of	Life-Cycle E emissions (electricity g	lb C02-eq./MMBtu enerated) based or 234.3 177.0 130.6 127.1 7.7 155 148.7 148.7 24.5	n 682362555
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste	Total 21.9% 0.5% 38.3% 0.3% 18.9% 6.3% 1 0.9% 9 0.5% 0.4% 2.8%	emissions (Ib CO2-eq/MMBI) electricity generated) based on IPCC data 1270 50 1127 130 62 1277 130 62 1377 1377 1377 1377 1377 1377 1377 1377	224.36 177.06 1306.02 127.13 7.76 1555 148.75 148.75 24.55 24.55 31.04	Ele	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Wood	Fraction of	Life-Cycle E emissions (electricity g	b C02-eq./MMBtu enerated) based or 234.3 177.0 130.6 127.1 7.7 155 148.7 148.7 245 31.0	n 6682336255584
Electricity Generation	Fossil Fuels	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Wast Geothermal	Total 219% 0.5% 38.3% 18.9% 6.3% 1.0.9% 9.0.5% 0.4% 0.4% 2.5% 0.2%	emissions (Ib CO2-eq/MMBtu electricity generated) based on IPCC data 1270 - 2000 117708 11770	224.36 177.06 1306.02 127.13 7.76 1555 148.75 148.75 24.55 24.55 31.04	Ele	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal	Fraction of Total	Life-Cycle E emissions (electricity g IPCC data	lb C02-eq./MMBtu enerated) based or 234.3 177.0 130.6 127.1 7.7 155 148.7 148.7 24.5	n 6682336255584
Electricity Generation Electricity Generation Technologies	Renewables	Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Waste Geothermal Solar	Total 21.9% 0.5% 38.3% 0.3% 0.3% 0.3% 0.3% 0.3% 0.3% 0.3% 0	emissions (Ib CO2-eq/MMBt) electricity generated) based on IPCC data 1270 80 11270 80 12713 776 1252 14875 14875 2458 3104 7.11	224.36 177.06 1306.02 127.13 7.70 15.55 148.75 148.75 24.55 31.04 7.11	Ele	ectricity Generation	n Technology n Fossil Fuels	Coal Petroleum Natural Gas Other Gases Nuclear Hydropower Biomass - Wood Biomass - Wood Biomass - Waste Geothermal Solar Wind	Fraction of Total	Life-Cycle E emissions (electricity g IPCC data	b C02-eq./MMBtu enerated) based or 234.3 177.0 130.6 127.1 7.7 155 148.7 148.7 245 31.0	n 6 8 2 3 6 2 5 5 8 4 1

... or input a custom mix of fossil-fuel and renewable sources.

	ERGY (DOE) OFFICE (ic, Energy & (ologios (TEC	UTEST)				_						ENERGY
Techno-economi	ic, Energy & C	arbon n	Jeunsue Tou	Return to Pia		ologies (TEC	11231)										Allow of
Raw Material Em	abodied Ener	-	ione and Cr		THINK FORC												ENERGY DIFICI
	ibodied cherg	y , Liniss	ions, and ou	7313													incremente t
									cial Benchmark (right). Note that res are needed, please modify in								
	New Technolog									Commercial Ben							
Technology Name	Waste Heat Recov		np)						Technology Name	Evaporative Conden							
Specific Product	Cooled Waste Wat								Specific Product	Cooled Waste Water							
Reference Quantity	2.00	Million Galls	JIN5						Reference Quantity	2.00	Million Gal	lons					
	(quantity)	(units)								(quantity)	(units)					Blue Cells: User inp numerical	ut - text or
	(or other sources and in be pasted as values	assumptions) in the Specifi	in the "References, ic Embodied Energy com MFI Enter MFI embodied	, Notes, and Assumpt column.					using similar *proxy* materials a embodied energy and carbon valu			embodied energy	Enter MFI embodied			assumptions (can be noce specific data a Other Cella: Not int	re available)
			energy data in this									energy data in this					
vew Technology - Raw Mat	terial locuts		column	column					Commercial Benchmark - Ra	w Material Insuts		column (# applicable)	column				
ten recurren.	Amount of	· · · ·	· · · ·	Specific Embodied	I	Embodied Energy	Embodied Carbon	Cost (\$)		In material inputs			Specific Embodied		Embodied Energy	Embodied Carbon (lbs	Cost (\$)
	Material		Specific Embodied		Specific Cost	(MMBtu)	(lbs co2-eq)	(per reference	100/08/ 0	Amount of Material		Specific Embodied		Specific Cost	(MMBtu)	c02-eq)	(per referen
Material Inputs (list)	(to produce reference guantity	unit	Energy (Btu/unit) (for this material)	eq/unit) (for this material)	(\$/unit) (for this material)	(per reference quantity of product)	(per reference	quantity of product)	Material Inputs (list)	(to produce reference quantity)	unit	Energy (Btu/unit) (for this material)	eq/unit) (for this material)	(\$/unit) (for this material)	[per reference quantity of product]	(per reference quantity of product)	quantity of product
ubrication (to run Fans)	2.340	1			\$6.00		11 lbs 002-e	\$14	City water supply to	17,010			0.002504	\$0.0020		43 lbs c02-e	producty
contraction (contain Painty)		~6	00,004		\$0.00	0.2 10000	1100000		evaporative condensers Biocide chemical additon to	11,010	Banoira	11.0004	0.002004	20.0020	0.3 (1111210	431030020	
Copper	0.367303565	t kg	39808.3	3 2.6		0.0 MMBtu	1 lbs 002-e	\$0	cooling loop for micro mitigation	3.322326031	gallons	119.5610231	0.0132	\$19.09	0.0 MMBtu	0.044 lbs c02-e	13
Elastomer	0.160569863	kg kg	94781.7	7 5.5		0.0 MMBtu	1 lbs c02-e	\$0	Steel low Alloy	0.317497841	kg	19051.1	1.4		0.0 MMBtu	0 lbs c02-e	
HDPE	0.005017808	kg kg	69190.6	6 1.6		0.0 MMBtu	0 lbs c02-e	\$0	Stainless Steel	0.349464668	kg	53741.394	6.2		0.0 MMBtu	2 lbs co2-e	
low alloyed steel	0.321139720	kg kg	19051.1	1 1.4		0.0 MMBtu	0 lbs c02-e	\$0	Aluminium	0.398757315	kg	146912.1	9.2		0.1 MMBtu	4 lbs co2-e	
Lubricating Oil (Manufacturing)	0.027096164	kg	80564.4	4 4.7		0.0 MMBtu	0 lbs c02-e	\$0	Bricks	0.346265477	Bricks	2843.46	0.2		0.0 MMBtu	0 lbs c02-e	
PVC	0.016056986	s kg	73171.5	5 2.4		0.0 MMBtu	0 lbs c02-e	\$0	Methacrylate	0.288178188	kg	110079.8148	5.9		0.0 MMBtu	2 lbs c02-e	
Reinforced Steel	1.304630137	kg	19051.1	1 1.4		0.0 MMBtu	2 lbs c02-e	\$0	Polyurethane	0.025744085	kg	68337.822	3.8		0.0 MMBtu	0 lbs c02-e	
									PVC	0.495184723	kg	73171.704	3.1		0.0 MMBtu	2 lbs 002-e	
		-	Total embodied	d energy and cost for	input materials:	0.3 MMBtu	15 lbs c02-e	\$14	-			Total embodied e	mergy and cost for i	nput materials:	0.5 MMBtu	52 lbs c02-e	8
				227,0	5.)	No	_						5377	20			
													sio	ns are calculated	automatically in M	FI. If calculating independe	intly, the la
			eve in the seleten	we wate teo imked b													
IPOC data for GWP and com	nbustion emissions fai										c 0	Dhac					
POC data for GWP and com	nbustion emissions fai		Factors		De			N/ a m									
POC data for GWP and com	nbustion emissions fai		Factors		Ra	w		Man	ufacturir	ען g	se	гназ	C				
IPOC data for GWP and com	nbustion emissions fai		Factors					Man	ufacturir		se	rnas	-				
*The IPA team defines *emi IPOC data for GVP and com Reference Data: 100-Yea	nbustion emissions fai		Factors				ls	Man	ufacturir	ng U F	se ner	rnas gv					
POC data for GWP and com	nbustion emissions fai			roject Basics	Ma	w ateria	ls	Man Ener	ufacturir gy	ng U E	se ner	'gy		Grid Mix		Summary Re	sults

Moving on, the Life Cycle Impacts category, is composed of three tabs make up the bulk of the environmental and economic assessments of the technologies.

In this tab, you will estimate						al inputs to manu	facturing for the Ne	w Technology (left)	and for the Comme	cial B	enchmark (right) 1	Note that t	he technology defini	tions and n	roduct definitions	
are imported by default fr entire analysis.																
	New Te	chnology	(at Indust	rial Scale)								[Commercial Benc	hmark		
Technology Name			ery (Heat Pun							те	chnology Name		Evaporative Condens	er		
Specific Product	Cooled V	Vaste Wate	er							Sp	ecific Product		Cooled Waste Water			
Reference Quantity	2.00		Million Gallo	ons						Re	ference Quantity		2.00	Million Gal	lons	
	(quantity)	(units)									8	(quantity)	(units)		
List all significant input m	aterials in th	e table bel	ow. Consider	ing the reference qu	antity specified in	the prior tab (and	shown above), spec	ify for each input ma	sterial the amount i	equire	d to produce the r	eference o	uanity, as well as the	e specific er	mbodied energy,	
specific embodied carbon	*, and specifi	c cost for e	ach material	. Follow the same p	rocess for the new f	echnology (left) a	nd commercial bend	chmark technology (i	right) to facilitate o	mpari	sons.					
Embodied energy and car	bon for input	materials i	may convenie	ently be estimated u	sing NREL's Materi	als Flow Through	Industry (MFI) tool (I	using the exact mate	erials if available, o	using	similar *proxy* ma	aterials as	an estimate). Indicat	te the speci	fic MFI material	
names used for estimates						tions ^a section bel	low. The tool tab link	ked below can be use	ed to easily extract	emboo	died energy and ca	arbon value	es from MFI results o	utput. MFI	embodied energy	
and carbon results can th	en be pasted	as values i	in the Specifi	c Embodied Energy	column.											
Calculator Tool: Extract	ing Embodie	d Energy	& Carbon fr	om MFI												
				Enter MFI embodied	Enter MFI embodied					2					Enter MFI embodied	
				energy data in this column	carbon data in this column										energy data in this column (ii applicable)	oarbon data in this column
New Technology - Raw M	aterial Inputs			1	1					Co	mmercial Benchm	nark - Raw	Material Inputs		1	1
		unt of			Specific Embodied		Embodied Energy		cost (\$)							Specific Embodie
Material Inputs		terial oduce		Specific Embodied Energy (Btu/unit)	carbon (lbs co2- eq/unit)	Specific Cost (\$/unit)	(MMBtu) (per reference	(lbs c02-eq) (per reference	(per reference quantity of		Material Inpu	rte .	Amount of Material (to produce		Specific Embodied Energy (Btu/unit)	
(list)		e quantity)	unit	(for this material)	(for this material)	(for this material		() quantity of product)	product)		(list)		reference quantity)	unit	(for this material)	(for this material
Lubrication (to run Fans)		2.340	kg	80,564	4.7	\$6.0	0.2 MMBtu	11 lbs CO2-e	\$14		ty water supply to aporative condens	sers	17,010	gallons	17.9394	0.00250
Copper	0.3	67303562	kg	39808.3	2.6	5	0.0 MMBtu	u 1 lbs c02-e	\$0	co	ocide chemical add oling loop for micr tigation		3.322326031	gallons	119.5610231	. 0.013
Elastomer	0.1	60569863	kg	94781.7	5.5	ř.	0.0 MMBtu	u 1 lbs CO2-e	\$0	ste	eel low Alloy		0.317497841	kg	19051.1	1
HDPE	0.0	05017808	kg	69190.6	1.6	i i	0.0 MMBtu	u 0 lbs c02-e	\$0	sta	ainless Steel		0.349464668	kg	53741.394	6
Low alloyed steel	0.3	21139726	kg	19051.1	1.4	ł	0.0 MMBtu	u 0 lbs CO2-e	\$0	Al	uminium		0.398757315	kg	146912.1	9
Lubricating Oil (Manufacturing)	0.0	27096164	kg	80564.4	4.7		0.0 MMBtu	u 0 lbs c02-e	\$0	Br	icks		0.346265477	Bricks	2843.46	o
PVC	0.0	16056986	kg	73171.5	2.4	1	0.0 MMBtu	u 0 lbs c02-e	\$0	M	ethacrylate		0.288178188	kg	110079.8148	5
Reinforced Steel	1.3	04630137	kg	19051.1	1.4	6	0.0 MMBti	2 lbs c02-e	\$0	Po	olyurethane		0.025744085	kg	68337.822	3
										PV	/C		0.495184723	kg	73171.704	3
				Total embodied	energy and cost for	input materials:	0.3 MMBtu	15 lbs c02-e	\$14	-					Total embodied e	inergy and cost fo
TECHTEST Full	Entry	Rapid Da	ita Entry	Project Basics	& Market	Functional	aw M	anufacturing	Use Phase	CapE	x OpEx Ur	nit	Grid Mix	Su	mmary Resu	ults
Landing Page Hor	ne Page	Home Pa	age	Benchmarks		Unit N	Naterials En	iergy	Energy		Co	onversion	Customization			hboard

The Raw Materials tab incorporates data on the materials required to produce the identified reference quantity for both technologies. This data includes, embodied energy, CO2 and cost.

	omic, Energy & Ca		FICIENCY AND				HTEST			Blue Cells: User input - tex numerical	tor						ENERGY
	line, Energy & or				age reenn	orogics (inco				Yellow Cells: User input -	select from						Concession in the local division of the loca
			eturn to Planni							dropdown							Office of ENERGY EFFICIENT RENEWABLE ENER
	ig Energy, Emissio									Purple Cells: Default data							RENEWABLE END
	rgy consumption (in the bl									EIA sector averages or star							
	tab. Follow the same proce									assumptions (can be user r							
	urce-to-site ratios (in the v better estimates are available									more specific data are avai							
	bustion Data tab (linked b				ing r ocention (o	in fore used to e.	and to the child		ar energy consumption.	Other Cells: Not intended	for editing						
				100000													
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	New Technology (at In	ndustrial Scale	1)							Commercial Benchmark	k						
echnology Name	Waste Heat Recovery (He	at Pump)							Technology Name	Evaporative Condenser							
pecific Product	Cooled Waste Water								Specific Product	Cooled Waste Water							
eference Quantity	2.00	Million Gallons							Reference Quantity	2.00	Million Gallons	0					
	(quantity)	(units)								(quantity)	(units)						12 C
ew Technology - Fr	nergy Consumption & Cost	Data (to produc	e reference ou	antity)					Commercial Benchma	rk - Energy Consumption &	Cost Data (to pro	duce referen	ce quantity)				
		Data entry	and the second								Data entry						
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		4		ground color to							4		kground color t				
	Energy Source				Source-to-Site	Primary Energy				Energy Source					Primary Energy		
	(Dropdowns available for	Onsite Energy		yr GWP (Ib	Ratio	Consumption,				(Dropdowns available for	Onsite Energy	Specific	yr GWP (lb	Ratio	Consumption,		
	Petroleum, Coal, and	consumption*		002-eq /		including offsite		GWP Emissions		Petroleum, Coal, and	Consumption*	Price	002-eq /		including offsite		GWP Emissions
Fuel or Energy Type	Renewable)	(MMBtu)	(\$/MMBtu)	MMBtu)	steam only)		(\$)	(lb c02-eq)	Fuel or Energy Type	Renewable)	(MMBtu)	(\$/MMBtu)	MMBtu)		losses (MMBtu)	Energy Cost (\$)	(lb c02-eq)
lectricity	Electricity	0.0048 MMBtu			2.8		\$0.10	0.5 lb co2-e	Electricity	Electricity	0.37 MMBtu	\$21.04	108.6	2.86	1.06 MMBtu	\$7.81	40.3 lb 002-
Petroleum	Diesel & distillate fuel oil	1	\$18.34		1.00				Petroleum	Diesel & distillate fuel oil	-	\$18.34	172.926	1.00			
oal	Anthracite		\$6.59		1.00				coal	Anthracite		\$6.59	229.8				
latural Gas	Natural Gas	0.0133 MMBtu	\$5.79		1.0		\$0.08	1.7 lb co2-e	Natural Gas	Natural Gas	0.01 MMBtu	\$5.79	130.6		0.01 MMBtu	\$0.08	1.7 lb c02
Renewable	Wood Biomass		\$2.89		1.00				Renewable	Wood Biomass		\$2.89 \$4.70	264.9				
steam	Steam and Hot Water**	-	\$4.70	146.4	1.20	·			Steam	Steam and Hot Water**		\$4.70	146.4	1.20			
sustom Input I		-	-	+		-			Custom Input I Custom Input II			\$12.22	146.9	1.00			
				-	1.00					Liquified Petroleum Gas		012.22	140.5	1.00			
								2.3 lb c02-e	custom Input III				6 3				
sustom Input III			\$4.31	227.4		0.03 MMBtu	\$0.18							1	1.07 MMBtu	\$7.89	42.1 lb CO2
			if fuel/electricity	-	ate the steam i		1								1.07 MMBCu	\$7.89	42.1 lb c0:
Link to reference da To avoid double-of Manufacturin If there are process- combustion of fuels if If there are no signif	Ita tab counting, only enter Steam Ig Process Emissi missions associated with (already captured above), icant process emissions, lo New Technology - Proces	ons (if appl either the new to eave this section	if fuel/electricity licable) echnology or con blank.	y used to gener mmercial bench		s not already inclu	ded above.	d 100-year GWP be	low, Do not include any er	nissions associated with Commercial Benchmark - F Emission Type	Process Emission	is (to produce	reference quar	ttity) Embodied	1.07 mm8ca	\$7.89	42.1 lb c02
Link to reference da To avoid double-of Manufacturin If there are process- combustion of fuels if If there are no signif	It a tab counting, only enter Steam g Process Emission emissions associated with (already captured above). Icant process emissions, Ir New Technology - Process Emission Type (chemical name or	either the new to eave this section as Emissions (to p Amount	if fuel/electricity licable) echnology or con blank. produce reference 100-year	y used to gener mmercial bench ce quantity) Suggested 100-year	mark technolog Embodied Carbon	s not already inclu	ded above.	d 100-year GWP be	low. Do not include any er	Commercial Benchmark - F Emission Type (chemical name or	Amount	100-Year	Suggested	Embodied Carbon	1.07 mmBca	\$7.89	42.1 lb c02
Link to reference da * To avoid double-co Manufacturin there are process. combustion of fuels there are no signif	to anthing, only enter Steam g Process Emission generation associated with (already captured above), icant process emissions, Is New Technology - Process Emission Type (chemical name or acronym)	ons (if appl either the new to eave this section is Emissions (to p Amount emitted (lb)	if fuel/electricity licable) echnology or con blank. produce reference 100-year GWP*	y used to gener mmercial bench ce quantity) Suggested 100-Year GWP	mark technolog Embodied Carbon (Ib CO2-eq)	s not already inclu gy, list the emission	ded above.	d 100-year GWP be	How, Do not include any er	Commercial Benchmark - F	14			Embodied Carbon		\$7.89	42.1 lb c02
Link to reference da * To avoid double-co Manufacturin there are process. combustion of fuels there are no signif	It a tab counting, only enter Steam g Process Emission emissions associated with (already captured above). Icant process emissions, Ir New Technology - Process Emission Type (chemical name or	either the new to eave this section as Emissions (to p Amount	if fuel/electricity licable) echnology or con blank. produce reference 100-year GWP*	y used to gener mmercial bench ce quantity) Suggested 100-Year GWP	mark technolog Embodied Carbon	s not already inclu gy, list the emission	ded above.	d 100-year GWP be	How, Do not include any er	Commercial Benchmark - F Emission Type (chemical name or	Amount	100-Year	Suggested 100-Year GWP	Embodied Carbon		\$7.89	42.1 lb c02
Link to reference da * To avoid double-co Manufacturin there are process. combustion of fuels there are no signif	to anthing, only enter Steam g Process Emission generation associated with (already captured above), icant process emissions, Is New Technology - Process Emission Type (chemical name or acronym)	ons (if appl either the new to eave this section is Emissions (to p Amount emitted (lb)	if fuel/electricity licable) echnology or con blank. produce reference 100-year GWP*	y used to gener mmercial bench ce quantity) Suggested 100-Year GWP	mark technolog Embodied Carbon (Ib CO2-eq)	s not already inclu gy, list the emission	ded above.	d 100-year GWP be	How, Do not include any er	Commercial Benchmark - F Emission Type (chemical name or	Amount	100-Year	Suggested 100-Year GWP 0 lbs c02-e	Embodied Carbon		\$7.89	42.1 lb c02
ustom Input III Link to reference da * To avoid double-co Manufacturin there are process, ombustion of fuels there are no signif	to anthing, only enter Steam g Process Emission generation associated with (already captured above), icant process emissions, Is New Technology - Process Emission Type (chemical name or acronym)	ons (if appl either the new to eave this section is Emissions (to p Amount emitted (lb)	if fuel/electricity licable) echnology or con blank. produce reference 100-year GWP*	y used to gener mmercial bench ce quantity) Suggested JOO-Year GWP	Embodied Carbon (Ib CO2-eq) 64 Ibs CO2-4	g, list the emission	ded above.	d 100-year GWP be	Now, Do not include any er	Commercial Benchmark - F Emission Type (chemical name or	Amount	100-Year	Suggested 100-Year GWP 0 lbs C02-e 0 lbs C02-e	Embodied Carbon (Ib CO2-eq)		\$7.89	42.1 lb co2
Link to reference da * To avoid double-co Manufacturin there are process. combustion of fuels there are no signif	to anthing, only enter Steam g Process Emission generation associated with (already captured above), icant process emissions, Is New Technology - Process Emission Type (chemical name or acronym)	ons (if appl either the new to eave this section is Emissions (to p Amount emitted (lb)	if fuel/electricity licable) echnology or con blank. produce reference 100-year GWP*	y used to gener mmercial bench ce quantity) Suggested 100-Year GWP	mark technolog Embodied Carbon (Ib CO2-eq) 64 Ibs CO2-4	g, list the emission	ded above.	d 100-year GWP be	How, Do not include any er	Commercial Benchmark - F Emission Type (chemical name or	Amount	100-Year	Suggested 100-Year GWP 0 lbs c02-e	Embodied Carbon (Ib CO2-eq)		\$7.89	42.1 lb co2
ustom Input III Link to reference da * To avoid double-co Manufacturin there are process, ombustion of fuels there are no signif	In State B Process Emissis Interview of the Steam Interview of the Steam I	ons (if appl either the new te eave this section is Emissions (to p Amount emitted (lb) 0.05	if fuel/electricity licable) echnology or con blank. produce reference 100-Year GWP* 1,300	y used to gener mmercial bench ce quantity) Suggested 100-Year GVP D Total:	Embodied Carbon (Ib c02-eq) 64 Ibs c02-4 64 Ibs c02-4	y, list the emission	ded above.			Commercial Benchmark - F Emission Type (chemical name or acronym)	Amount emitted (lb)	100-Year GWP*	Suggested 100-Year GWP 0 lbs C02-e 0 lbs C02-e	Embodied Carbon (Ib CO2-eq)		\$7.89	42.1 lb co2
ustom input III ink to reference da To avoid double-co lanufacturin there are process. imbustion of fuels there are no signif	trans counting, only enter Steam g Process Emissi missions associated with missions associated with idealy captured above), cash process emissions, in New Technology - Process Emission Type (chemical name or accomm) R-134e * Use IPOC ABS values for	ons (if app) either the new to eave this section as Emissions (to p Amount emitted (lb) 0.05	if fuel/electricity flicable) echnology or con blank: porduce reference 100-Year GWP* 1,300	y used to gener mmercial bench ce quantity) Suggested 100-Year GVP D Total:	Embodied Carbon (Ib c02-eq) 64 Ibs c02-4 64 Ibs c02-4	y, list the emission	ded above.			Commercial Benchmark - F Emission Type (chemical name or	Amount emitted (lb)	100-Year GWP*	Suggested 100-Year GWP 0 lbs C02-e 0 lbs C02-e	Embodied Carbon (Ib CO2-eq)		\$7.89	42.1 lb co2
Link to reference da * To avoid double-co Manufacturin there are process, ombustion of fuels there are no signif	In State B Process Emissis Interview of the Steam Interview of the Steam I	ons (if app) either the new to eave this section as Emissions (to p Amount emitted (lb) 0.05	if fuel/electricity flicable) echnology or con blank: porduce reference 100-Year GWP* 1,300	y used to gener mmercial bench ce quantity) Suggested 100-Year GVP D Total:	Embodied Carbon (Ib c02-eq) 64 Ibs c02-4 64 Ibs c02-4	y, list the emission	ded above.			Commercial Benchmark - F Emission Type (chemical name or acronym)	Amount emitted (lb)	100-Year GWP*	Suggested 100-Year GWP 0 lbs C02-e 0 lbs C02-e	Embodied Carbon (Ib CO2-eq)		\$7.89	42.1 lb 002
Austom Input III Link to reference de * To avoid double-c Manufacturin there are process. ombustion of fuels there are no signif	trans counting, only enter Steam g Process Emissi missions associated with missions associated with idealy captured above), cash process emissions, in New Technology - Process Emission Type (chemical name or accomm) R-134e * Use IPOC ABS values for	ons (if app) either the new to eave this section as Emissions (to p Amount emitted (lb) 0.05	if huel/electricity liccable) echnology or con blank. wroduce referenc 100-Year 0/WP* 1.300 WWP* 1.300 WWP 1.300 WWP 1.300	y used to gener mmercial bench ce quantity) Suggested 100-Year GWP D Total: Total:	Embodied Carbon (Bo 02-eq) 64 lbs 02-4 64 lbs 02-4 the GWP Data	y, list the emission	ded above.		nost common emissions ty	Commercial Benchmark - f Emission Type (chemical name or acronym)	Amount emitted (lb)	100-Year GWP*	Suggested 100-Year GWP 0 lbs C02-e 0 lbs C02-e	Embodied Carbon (lb C02-eq) 0 lbs C02-e		\$7.89	42.1 lb 002
Link to reference da * To avoid double-co Manufacturin there are process. combustion of fuels there are no signif	In table gprocess Emissis gprocess Emissis and the second with larleredy optimed above). New Inschwalger Process (chemical name or acromym) R-134a * Use IPOC ARB values for Beference Data Tables Of	ons (if app) either the new to eave this section as Emissions (to p Amount emitted (lb) 0.05	if huel/electricity liccable) echnology or con blank. wroduce referenc 100-Year 0/WP* 1.300 WWP* 1.300 WWP 1.300 WWP 1.300	y used to gener mmercial bench ce quantity) Suggested 100-Year GVP D Total:	Embodied Carbon (Bo 02-eq) 64 lbs 02-4 64 lbs 02-4 the GWP Data	s not already inclu gy, list the emission tab (linked below)	ded above.			Commercial Benchmark - F Emission Type (chemical name or acronym)	Amount emitted (lb)	100-Year GWP*	Suggested 100-Year GWP 0 lbs c02-e 0 lbs c02-e Total	Embodied Carbon (Ib CO2-eq)		ummary	42.1 lb co2

The Manufacturing Energy tab calculates the energy required to manufacture the reference quantity...

U.S. DEPARTM	ENT OF ENERGY (DOE) OFFICE	OF ENERGY EF	FICIENCY AND I	RENEWABLE E	NERGY (EERE)							0	lue Cells: User inp	and a local or				
Techno-ec	onomic, Energy	v & Ca	rbon Heuri	istic Tool fo	r Early St	age Techno	ologies (TEC	HTEST)						umerical	ut - text or				
			D	eturn to Planni	na Danas	0		1					Y	ellow Cells: User i	input - select	t from			
10 months at	wind Franks Fr				NE FORE									ropdown					_
	uring Energy, Er													urple Cells: Defau					
	e energy consumption (i Unit tab. Follow the sar													A sector averages					
	id source-to-site ratios													ssumptions (can be ore specific data a					
	y, if better estimates a													ther Cells: Not int					
	Combustion Data tab (Ľ	uler cens, we ne	ended for ed	unnig			
	[-						
	New Technolog			•)										mercial Bench					
Technology Nar	and a second sec	2102020001010	t Pump)									nology Name	(accord)	orative Condense	er				
Specific Produc		2202									37673	ific Product		ed Waste Water					_
Reference Quar	ntity 2.00		Million Gallons	É.							Refer	rence Quantity	2.00		Mill	lion Gallons			
	(quantity)		(units)										(quar	ntity)	(uni	its)			
New Technolog	y - Energy Consumption	n & Cost I	Data (to produc	e reference qua	ntity)					_	Com	mercial Bench	mark - En	ergy Consumptio	on & Cost I	Data (to pro	duce referen	ce quantity)	
	, chergy consumption		Data entry								1			iergy consumption		ata entry			and the second
1			Data entry		or data* (Can b modifying value										U	ALC ENLLY		ctor data* (Can If modifying va	
			4		ground color to											4		kground color t	
	Energy Sou	rce			Specific 100-		Primary Energy							Energy Source				Specific 100-	Source-to
	(Dropdowns avai		Onsite Energy		yr GWP (lb	Ratio	Consumption,						(Dro	pdowns availabl	e for Ons	site Energy	Specific	yr GWP (lb	Ratio
	Petroleum, Coa		Consumption*	Specific Price	co2-eq /			Energy Cost	GWP Emis		1000			etroleum, Coal, a			Price	CO2-eq /	(electricit
Fuel or Energy		e)	(MMBtu)	(\$/MMBtu)	MMBtu)	steam only)	losses (MMBtu)	(\$)	(lb co2-ed			l or Energy Typ		Renewable)		MBtu)	(\$/MMBtu)	MMBtu)	steam onl
Electricity	Electricity		0.0048 MMBtu	\$21.04	108.6	2.86	0.01 MMBtu	\$0.10	0.5 lb	со2-е	Elect		Elect			0.37 MMBtu	\$21.04	108.6	
Petroleum	Diesel & distillate	e fuel oil		\$18.34	172.926	1.00		-	<u> </u>			oleum		el & distillate fue	loil		\$18.34 \$6.59	172.926	
Coal	Anthracite		0.0133 MMBtu	\$6.59 \$5.79	229.8 130.6	1.00					coal	1	1007707	racite		0.01 MMBtu	\$5.79		3
Natural Gas	Natural Gas		0.0133 MMB(0	\$0.79	264.9	1.00	0.01 MMBtu	\$0.08	1.7 lb	со2-е		ural Gas		ral Gas		0.01 MMBtu	\$2.89	264.9	94 Hi
Renewable	Wood Biomass		-	\$2.89	146.4	1.00					Stea	ewable		d Biomass			\$4.70		54 SS
Custom Inpu	Steam and Hot W	ater**	-	54.70	140.4	1.20				-	100000	om Input I	stea	m and Hot Water			54.70	140.4	-
Custom Inpu				0					<u> </u>		1000000000	om Input II	1.7 m 1				\$12.22	146.5	
	t III Petroleum Coke	-	-	\$4.31	227.4	1.00				-		com Input III	Liqui	fied Petroleum G	ias		412.22	140.0	-
custom mpu	Petroleum coke			94.51	221.4	1.00	0.03 MMBtu	\$0.18	23 lb	000	Cusi	om input in			_				1
* Link to referen	an deserve						0.03 MMBtu	50.18	2310	cuse									
	ible-counting, only ente	or Steam o	data in this row	if fuel/electricity	used to dener	ate the steam is	not already inclu	ad above											
TO AVOID OUT	ione-counting, only ente	in Second e		in ruley electricity	used to gener	ate the steam is	not alleady mouth	Jeu above.											
Manufact	wind Drococo F	minnin	ne lif ann	licoble															_
	uring Process E														2				
	cess emissions associat uels (already captured		either the new to	echnology of con	imercial bench	mark technolog	y, list the emission	is and associate	ed 100-year	r GWP be	now. Do r	tot include any	emission	is associated wit	n:				
	significant process emis		ave this section	blank.															
	New Technology	- Process	Emissions (to r	roduce reference	e quantity)								Com	mercial Benchma	ark - Proce	ess Emission	s (to produce	reference qua	ntity)
TECHTEST		Rapid Dat		roiect Basics 8		Functional	Raw	Manufac	turing	Use P	hase	CapEx Or			Grid Mix		Summary	Results	
Landing Page		Home Pag		enchmarks		Unit	Materials	Energy		Energ					Customiza		Tables	Dashboa	rd

...broken down by fuel type.

	ENERGY (DOE) OFFICE OF ENER	GA FEFEICIENC.	Y AND RENEW	ABLE ENERGY (EERE)							Blue Cells: User input - text or		
Techno-econom	nic, Energy & Carbon H	euristic T	ool for Ea	ly Stage Techno	logies (TE	CHTEST)					Numerical Yellow Cella: User input - select from		ENERGY
		turn to Plann		, ,							dropdown Purple Cells: Default data based on		Office of ENERGY EFFICIENCY &
Jse Phase Ener	rgy and Emissions										EIA sector averages or standard assumptions (can be user modified if more specific data are available) Other Cells: Not intended for editing		RENEWABLE ENERGY
ch systems. For exam hase impacts, leave th	ny technology expected to have an uple, a lightweight material may p his section blank. Technologies for hase impacts because the end-use	ovide fuel savi which the Use	ngs (compared Phase is <u>not</u> e	to typical materials) whe spected to be important	en used in a veh	nicle; and an energy-effi-	cient device may pro	ovide electricity savings	(compared to typical devi-	ces) when used	in a consumer applicatio	n. If the technology is	s not expected to have use
evaluate the use pha	ase energy impact, estimate the t	atal U.S. annua	l energy consu	mption (for the end-use r	narket impacte	d by the technology) ba	sed on two scenario	S:					
1. Current Annual	Energy Consumption												
	nnual Energy Consumption, Based	on *Overnight	Replacement*	with New Technology									
the fourrentl reenario	o, assume the current market size	and market of	anditions cons	ider the entire market i	ocluding all fac	lities and manufactures	r In the Muschight	Paplacamenti connario	accume a hunothetical m	artest in which	the new technology war is	mmadiately and fully	deployed (at its maximum
nter data on an an	re), with the market size and all o mual basis in the blue cells	below, consi	dering the U	S. market and break	ting down by								
site ratio (based on E	EIA and IPCC reference data) are p		purple cells. Th	Data entry**	itten if more ac	curate facility- or indust	try-specific data are	available. Provide your	Data entry**	source data, a	nd calculations in the sec	tions at the bottom o	f this tab.
			fied if needed)	4					4				
		Ŧ	+	Currei		6. Energy & Emission of on current technolog		Phase	Нур		ual Energy & Emissi overnight replacement* v		Phase
		Specific 100- yr GWP (lb c02-eq /	Source-to- Site Ratio (Btu primary	Annual Oncite Energy	Specific Price	Annual Primary Energy Consumption, including offsite losses	Annual Associated	Annual Associated GWP Emissions (tons	Annual Energy Consumption	Conscilio Drice	Annual Primary Energy	Annual Associated	
ctor & Energy Type	Energy Source	MMBtu)		Consumption (MMBtu)		(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units)	(\$/MMBtu)	Consumption (MMBtu)	Cost (\$)	Annual Associated GWP Emissions (tons CO2-eq)
ctor & Energy Type	Energy Source	MMBtu)											Annual Associated GWP Emissions (tons CO2-eq)
	Energy Source	MMBtu)	/ Btu onsite)	Consumption (MMBtu)			Cost (\$)	CO2-eq)	(fuel specific units)	(\$/MMBtu)	Consumption (MMBtu)		Emissions (tons CO2-eq)
ectricity	Industrial	MMBtu) Sector	/ Btu onsite)	Consumption (MMBtu)	(\$/MMBtu)	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units)	(\$/MMBtu)	Consumption (MMBtu) 309,182,690 MMBtu	Cost (\$)	Emissions (tons CO2-eq)
ectricity troleum Look Up	Industrial Electricity	MMBtu) Sector 108.6	/ Btu onsite) 2.86 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units)	(\$/MMBtu)	Consumption (MMBtu) 309,182,690 MMBtu	Cost (\$)	Emissions (tons CO2-eq)
ectricity troleum Look Up al Look Up	Industrial Electricity Motor Gasoline	MMBtu) Sector 108.6 161.8	/ Btu onsite) 2.86 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units)	(\$/MMBtu) \$21.04 \$21.54 \$7.66	Consumption (MMBtu) 309,182,690 MMBtu	Cost (\$)	Emissions (tons c02-eq) 5,870,785.4 tons c02-
ectricity troleum Look Up al Look Up itural Gas	Industrial Electricity Motor Gasoline Coal Coke	MMBtu) Sector 108.6 161.8 250.5	/ Btu onsite) 2.86 1.00 1.00 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66	Consumption (MMBtu) 309,182,690 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-
ectricity etroleum Look Up Mai Look Up stural Gas enewable Look Up	Industrial Electricity Motor Gasoline Coal Coke Natural Gas	MMBtu) Sector 108.6 161.8 250.5 130.6	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-e
ectricity stroleum Look Up al Look Up stural Gas newable Look Up eam istom Input I	Industrial Electricity Motor Gasoline Coal Coke Natural Gas Solar	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-e
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ectricity troleum Look Up al Look Up tural Gas inewable Look Up eam stom input I stom input II	Industrial Electricity Motor Gasoline Coal Coke Natural Gas Solar	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-
ectricity troleum Look Up al Look Up tural Gas inewable Look Up eam stom input I stom input II	Industrial Electricity Motor Gasoline Coal Coke Natural Gas Solar	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0 146.4	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-
sctricity troleum Look Up al Look Up tural Gas newable Look Up eam stom Input I stom Input II stom Input II	Industrial Electricity Motor Gassoline Coal Coole Natural Gas Solar Steam and Hot Water*	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0 146.4	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00 1.20	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-e
ectricity troleum Look Up al Look Up tural Gas newable Look Up eam stom Input I stom Input II stom Input II stom Input II troleum Look Up	Industrial Electricity Motor Gasoline Coal Code Viatural Gas Solar Steam and Hot Water* Transportati	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0 146.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00 1.20	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$2.54 \$7.66 \$5.79 \$14.07 \$4.70	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$7.66 \$5.79 \$14.07 \$4.70	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-e
ectricity troleum Look Up al Look Up tural Gas newable Look Up eam stom Input I stom Input II stom Input II stom Input II troleum Look Up	Industrial Electricity Hotor Gasoline Coal Cole Steam and Hot Water* Steam and Hot Water* Transportati Electricity	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0 146.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	/ Btu onsite) 2.86 1.00 1.00 1.00 1.00 1.20 2.86	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$4.70 \$4.70 \$4.70 \$21.04	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07 \$4.70 \$4.70 \$21.04	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-e
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ectricity troleum Look Up at Look Up tural Gas schemable Look Up eam schem Input II schem Input II schem Input II schem Input II schem Look Up tural Gas newable Fuels	Industrial Electricity Notor Gasoline Coal Cole Instance Solar Solar Steam and Hot Water* Transportati Electricity Notor gasoline Hatural Gas (popelines and fue)	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0 146.4 146.4 0 0 0 Sector 108.6 163.3 138.2 138.2	/ Btu onsite) 2.86 1.00 1.0	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$7.66 \$5.79 \$14.07 \$4.70 \$4.70 \$4.70 \$4.70	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07 \$4.70 \$5.79 \$5.79	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons c02-eq) 5,870,785.4 tons c02-e
ctor & Energy Type ectricity troleum Look Up sal Look Up sal Look Up sal Look Up sal Look Up sam stom input I istom input II istom input II istom Look Up troleum Look Up troleum Look Up storal Gas newable Fuels stom Input II	Industrial Electricity Notor Gasoline Coal Cole Instance Solar Solar Steam and Hot Water* Transportati Electricity Notor gasoline Hatural Gas (popelines and fue)	MMBtu) Sector 108.6 161.8 250.5 130.6 31.0 146.4 146.4 0 0 0 Sector 108.6 163.3 138.2 138.2	/ Btu onsite) 2.86 1.00 1.0	Consumption (MMBtu)	(\$/MMBtu) \$21.04 \$7.66 \$5.79 \$14.07 \$4.70 \$4.70 \$4.70 \$4.70	(MMBtu)	Cost (\$)	CO2-eq)	(fuel specific units) 108,130,193.05 MMBtu	(\$/MMBtu) \$21.04 \$21.54 \$7.66 \$5.79 \$14.07 \$4.70 \$5.79 \$5.79	Consumption (MMBtu) 309,182,690 MMBtu -222,771,704 MMBtu	Cost (\$) \$2,275,424,343.79	Emissions (tons CO2-eq) 5,870,785.4 tons CO2-e
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And the Use Phase Energy tab quantifies the expected energy impacts from the product's final use.

_	Inhase impacts leav	e this section blank. Technolog	res for which the	se Phase in	001 P	enerted to be importat	t include tec	hnologies	s where the endus	e product is identic	al to that produced	d using	current typical technolog	ies For examp	ale a new production r	ute for a commodity o	bemical woul
		se phase impacts because the e															
	To evaluate the use	phase energy impact, estimate	e the <u>total U.S. an</u>	ual energy	consu	nption (for the end-use	e market impa	acted by f	the technology) ba:	sed on two scenario	5:						
		unt Farmer Grandung															
		nual Energy Consumption	Deved as Reven	det Beeleen													
	2. Hypothetica	al Annual Energy Consumption,	Based on "Overni	лі неріасе	ment-	with New Technology											
	In the "Current" sce	nario, assume the current mark	ket size and mark	t condition:	. cons	ider the entire market	including all	facilities	s and manufacturer	s. In the "Overnight	Replacement* sce	enario, a	assume a hypothetical m	arket in which	the new technology wa	s immediately and fully	y deployed (i
	anticipated market	share), with the market size an	d all other marke	conditions	held c	onstant (this is a simpl	ification).										
		on EIA and IPCC reference data															
	ro-site tatio (oaseo	on Eps and iPoo reference data	i) are provided in	ne purple o	ans. In	ese data may de over-	written ir mor	e accurac	te lacinty- or moust	try-specific data are	available. Provio	e your r	elerences, assumptions,	source data, a	no calculations in the	ections at the outcom	or this tao.
			Dela	t sector dat		Data entry**							Data entry**				
				odified if ne		1							L				
11			(con de n	J	cucuj				wards & Freelanders	- Product Har	Change .			the birst as	and the same is made	alaan Daadaat Daa	
1			*			Curr			current technologi	ns - Product Use	Phase		нурс		nual Energy & Emis overnight replacement		
			Specific :	00- Source	to.		1		Annual Primary	les in user		_		(ubseu un	I	and then too moregy	'T
			yr GWP (ergy Consumption.		Annual Associa	ated	Annual Energy				
			co2-eg /	(Btu pr		Annual Onsite Energ	Specific Pr			Annual Associated				Specific Price	Annual Primary Energy	Annual Associated	Annual A
	Sector & Energy Typ	e Energy Source	MMBtu)	/ Btu o	nsite)	Consumption (MMBtu) (\$/MMBtu)	(MMBtu)	cost (\$)	CO2-eq)	2	(fuel specific units)	(\$/MMBtu)	Consumption (MMBt	u) Cost (\$)	Emission
		Indu	strial Sector														
	Electricity	Electricity		8.6	2.86	44,577,450.00 MMB			27,462,788 MMBtu	\$938,060,055.69	2,420,274 tons	: co2-e	108,130,193.05 MMBtu	\$21.04		tu \$2,275,424,343.7	9 5,870,7
	Petroleum Look U	p Motor Gasoline	1	1.8	1.00		\$21	.54						\$21.54			
	Coal Look Up	Coal Coke		0.5	1.00			.66						\$7.66			
	Natural Gas	Natural Gas		0.6	1.00			6.79					-222,771,704 MMBtu	\$5.75		tu -\$1,290,746,544.3-	4 -14,548,0
	Renewable Look L	Poordi		1.0	1.00		\$14							\$14.07			-
	Steam	Steam and Hot Water*	1	6.4	1.20		\$4	.70						\$4.70			
	Custom Input I			_													-
	Custom Input II			_													
	Custom Input III																
								_									
		Transp	ortation Secto														1
	Electricity	Electricity	1	8.6	2.86		\$21	.04			1			\$21.04			
	Petroleum Look L	IP Motor gasoline	1	5.3	1.00		\$18	.64						\$18.64			
	Natural Gas	Natural Gas (pipelines an	d fuel) 1	8.2	1.00		\$5	6.79						\$5.79	P		
	Renewable Fuels	Biomass	1	5.3	1.00		\$2	.89						\$2.89	•		
	Custom Input I												9				
	Custom Input II				_			14									
	Custom Input III																
						Current Annu Energy & Emission		12	27,462,788 MMBtu	\$938,060,055.69	2,420,274 tons	002-e	Hypothetical Annual Energy & Emissions:		86,410,986 MMB	tu \$984,677,799.4	5 -8,677
	-					or equivalent	y:		127 TBtu		2 million tons	002-e	or equivalently:		86 TB	tu	-9 mi
	*Link to reference da	ita tab															
	References,	Notes, and Assumpti	ions														
		•					_			Use Pl						_	
TE	CHTEST I	Full Entry Rapid Data	a Entry Pr	ject Basi	cs &	Market Fund	tional	Raw	Manufac	turing	Cai	pEx	OpEx Unit	Grid Mi	x Sumr	nary Results	
Lar	nding Page	Home Page Home Pag	e Be	, nchmarks		Unit		Materi	ials Energy	Energy	/		Conversion	n Custom			rd
(0 mil							221113101	0.001	- dbie	2001000	

And the Use Phase Energy tab quantifies the expected energy impacts from the product's final use.

		e) office of energy & Carbon Hei					ECHTEST)				_		_	ENERGY
Techno-ec	onomic, Energ		eturn to Plann		Stage rec	iniologies (1	ECHIESI)							Officeal
Manufact	uring Capital I	xpenses (CapE		- ALL SALE	-									ENERGY EFFICIENCY & RENEWABLE ENERGY
			.,											
In this tab, you	will estimate capital	expenses (CapEx - i.e., r	non-recurring / a	one-time costs) for the new tec	hnology (left) and f	or the commercial b	enchmark (right).					Blue Cells: User in numerical	nput - text or
The reference p	roduction volumes (a	s entered into the Refe	rence Volume ta	ab) are shown I	below for each te	echnology. If you ne	eed to change these	, edit in the Refere	nce Volume tab.					r input - select from
													dropdown Purple Cells: Defi	and data based on
	New Technology	(at Industrial Scale	e)					Commercial Be	enchmark				EIA sector average	
Technology Nar	ne Waste Heat Recov	try (Heat Pump)					Technology Nam	e Evaporative Cond	lenser				assumptions (can b more specific data	
Specific Produc	t Cooled Waste Wat	er					Specific Product	Cooled Waste Wa	ter				Other Cells: Not in	
Reference Volu	me 2.00	Million Gallons					Reference Volum	1 2.00	Million Gallons					
	(ref volume)	(units)						(ref volume)	(units)					
		the annual production v							, indicate the annual pr					
expenses in the		ne expenses). This facili	ty size will also	be used as a b	asis to assess o	perating	capital expenses	(i.e., one-time exp	enses). This facility size	e will also be use	ed as a basis to	assess operati	ng expenses in th	he next tab.
Annual Facili	-		1				Annual Facility	v	1	T I				
Production		Million Gallons	of cooled W	acte Water	ner vear		Production o		Million Gallons	of cooled W	Vaste Water	per year		
				and motor	per yeur									
End-use Produc	ct:			and motor	per yeur		End-use Product	-	(, jeen		
End-use Product	(facility product.) (facility product.) w technology (left) an ed above. For each ite culate and include the		ark (right), list ca	apital expenses ate the purcha	s in the tables b ase price and exp	ected lifetime (for	End-use Product cility of the size and depreciation purpos	(facility product.) (typical production ses). For financed						
End-use Product For both the ne volume indicate equipment, cal- capital* expens	(facility product.) (facility product.) w technology (left) an ed above. For each ite culate and include the les.	(units) d commercial benchma m listed, name the exp	ark (right), list ca bense and estima the spaces belo	apital expense: ate the purcha w to list refere	s in the tables b ase price and exp ences, assumptic	ected lifetime (for ons and calculation:	End-use Product cility of the size and depreciation purpos s. Do not include rec	(facility product.) (typical production ses). For financed						
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End-use Produc For both the ne volume indicate equipment, cal- capital* expens A default value New Technolog CapEx Category Process	t: (facility product.) wr technology (left) an and above. For each ite culate and include the les. of 5% of CapEx annua gy - Capital Expenses ((units) d commercial benchma m listed, name the exp e cost of financing. Use ally is assumed for annu (CapEx) Capital Expense Items (descriptions)	ark (right), list ca pense and estim the spaces belo tal equipment ar Purchase Price (\$)	apital expenses ate the purcha w to list refere nd facility main Expected Equipment Lifetime	s in the tables b ase price and exp ences, assumption ntenance. This vi Annual Capital Cost for Facility (\$)	ected lifetime (for ins and calculation alue may be adjust Capital Cost for Functional Unit (\$)	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. Commerical Ben CapEx Caregory Process	(facility product.) (typical production ses). For financed coverable *working	y - Capital Expenses (C Capital Expense Items (descriptions) Evaporative condensers (4 total)	purchase Price (\$)	Expected Equipment Lifetime (years)	Annual Capital Cost for Facility (\$)	Annual Capital Cost (\$)	for Functional Unit (\$)
End-use Produc For both the ne volume indicate equipment, calcapital* expens A default value New Technolog	ct: (facility product.) w technology (left) ed above. For each at cutate and include the esc. of 5% of CapEx annue gv - Capital Expenses i Examples	(units) d commercial benchma m listed, name the exp e cost of financing. Use tilly is assumed for annu (CapEx) Capital Expense Hems (descriptions) Waste Heat Recovery	ark (right), list ca pense and estim the spaces belo tal equipment ar Purchase Price (\$)	apital expenses ate the purcha w to list refere nd facility main Expected Equipment Lifetime	s in the tables b ase price and exp ences, assumption ntenance. This vi Annual Capital Cost for Facility (\$)	ected lifetime (for ins and calculation alue may be adjust Capital Cost for Functional Unit (\$)	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. <u>Commerical Ben</u> <u>CapEx Category</u>	(facility product.) (typical production see), For finance coverable "working nchmark Technolog Examples	y - Capital Expenses (C Capital Expense Items (descriptions) Evaporative condensers (4 total)	purchase Price (\$)	Expected Equipment Lifetime (years)	Annual Capital Cost for Facility (\$)	Annual Capital Cost (\$)	for Functional Unit (\$)
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End-use Produc For both the ne volume indicate equipment, cal- capital* expens A default value New Technolog CapEx Category Process	tt; (facility product.) w technology (left) an ed above, For each it culate and include the es. of 5% of CapEx annuc y - Capital Expenses (Estamples furnaces, reactors	(units) d commercial benchma m listed, name the exp e cost of financing. Use e cost of financing. Use e cost of financing. Use (application) Capital Expense Tenses (descriptione) System (e.g. HP)	Purchase Price (\$) \$254,306 Process Equ	apital expenses ate the purcha w to list refere nd facility main Expected Equipment Lifetime	s in the tables b isse price and exp noes, assumption tenance. This w Annual Capital Cost for Facility (\$) \$25,431 \$25,431	Capital Cost for Functional Unit (\$) \$63.67 \$70	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. Commerical Ben CapEx Caregory Process	(facility product.) I typical production ses). For financed coverable "working homark Technolog Examples furnaces, reactors	y - Capital Expenses (Ca Capital Expense Hens: (derotipiona) Exuporative condensers (4 total)	Purchase Price (\$) \$1,000,000 Process Eq	Expected Equipment Lifetime (years) 25 uipment Total:	Annual Capital Cost for Facility (\$) \$40,000 \$40,000.00	Annual Capital Cost (\$) \$40,000 \$40,000	for Functional Unit (\$) (\$109,59 \$109,59
End-use Produc For both the ne volume indicate equipment, cal- capital* expens A default value New Technolog CapEx Category Process	ct. (#acity product.) w technology (left) an ed above. For each it culate and include the es. of 5% of CapEx annue y - Capital Expenses i Examples furnaces, reactors piping, control	(units) d commercial benchma m listed, name the exp e cost of financing. Use tilly is assumed for annu (CapEx) Capital Expense Hems (descriptions) Waste Heat Recovery	Purohase Price (\$) \$254,306	apital expenses ate the purchas w to list refere and facility main Expected Equipment Lifetime (years) 10 ipment Total:	s in the tables b see price and exp ences, assumption ntenance. This with Annual Capital Cost for Facility (8) \$ 25,431	Capital Cost for Functional Unit (\$) \$63.67	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. Commerical Ben CapEx Caregory Process	(facility product.) (facility production ses), For financed coverable "working coverable "working coverable" "working coverable "working coverable" "coverable" "coverab	y - Capital Expenses (C Capital Expense Items (descriptions) Evaporative condensers (4 total)	Purohase Price (1) \$1000,000	Expected Equipment Lifetime (years) 25 uipment Total:	Annual Capital Cost for Facility (\$) \$40,000 \$40,000.00	Annual Capital Cost (\$) \$40,000 \$40,000	for Functional Unit (\$) (\$109,59 \$109,59
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End-use Produc For both the ne volume indicate equipment, calc capital* expenses A default value New Technolog CapEx Category Process Equipment Non-process	tt. (#cality product.) we technology (fett) an ed above. For each its culate and include the es. of 5% of CapEx annuz y-Capital Expenses (perception for the second furnaces, reactors piping.control systems, pover	(unite) (unite	Ark (right), list ca errise and estimative spaces belo ial equipment ar Purchase Price (\$) \$254,306 Process Equ \$50,000	apital expenses ate the purchas to list reference of the second second the second second second the second	s in the tables b se price and exp neces, assumptic ntenance. This w Annual Capital Cost for Facility (\$) \$25,431 \$1,429	Capital Cost for Functional Unit (\$) \$63.67 \$70 \$3.31	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. Commerical Ben CapEx Caregory Process Equipment Nonprocess	(facility product.) (facility production ses), For financed coverable "working coverable "working coverable" "working coverable "working coverable" "coverable" "coverab	y - Capital Expenses (Ca Capital Expense Hens: (derotipiona) Exuporative condensers (4 total)	Purchase Price (\$) \$1,000,000 Process Eq	Expected Equipment Lifetime (years) 25 uipment Total:	Annual Capital Cost for Facility (\$) \$40,000.00 \$1423	Annual Capital Cost (\$) \$40,000 \$40,000 \$1,429	for Functional Unit (\$) \$109.59 \$109.59 \$109.59 \$13.91
End-use Produc For both the ne volume indicate equipment, calc capital* expenses A default value New Technolog CapEx Category Process Equipment Non-process	tt. [fledityproduct.] If Belityproduct.] If Belityproduct.] If the second secon	(unite) d commercial benchma m listed, name the exp cost of financing. Use cost of financing. (CapEx) Capital Expense Rems Rems Varie Have Recovery System (e.g. PP) Piping Piping	In (right), list ca pense and estim the spaces belo lat equipment at Purchase Price (8) \$254,306 \$50,000	apital expenses ate the purchas to list reference of the second second the second second second the second	s in the tables b isse price and exp noes, assumption tenance. This w Annual Capital Cost for Facility (\$) \$25,431 \$25,431	Capital Cost for Functional Unit (3) \$53,67 \$70 \$3,91 \$44	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. Commerical Ben CapEx Caregory Process Equipment Nonprocess	(facility product.) (facility production ses), For financed coverable "working coverable "working coverable" "working coverable "working coverable" "coverable" "coverab	y - Capital Expenses (Ca Capital Expense Hens: (derotipiona) Exuporative condensers (4 total)	Purchase Price (\$) \$1,000,000 Process Eq	Expected Equipment Lifetime (years) 25 uipment Total:	Annual Capital Cost for Facility (\$) \$40,000 \$40,000.00	Annual Capital Cost (\$) \$40,000 \$40,000 \$1,423 \$1,423	for Functional Unit (\$) \$109,59 \$109,59 \$109,59 \$109,59 \$3,91 \$3,91 \$3,91 \$3,91
End-use Produc For both the ne volume indicate equipment, calc capital* expenses A default value New Technolog CapEx Category Process Equipment Non-process	tt. (#cality product.) we technology (fett) an ed above. For each its culate and include the es. of 5% of CapEx annuz y-Capital Expenses (perception for the second furnaces, reactors piping.control systems, pover	(unite) (unite	Ark (right), list ca errise and estimative spaces belo ial equipment ar Purchase Price (\$) \$254,306 Process Equ \$50,000	apital expenses ate the purchas w to list reference and facility main Expected Equipment Lifetime (years) 10 aipment Total: aipment Total:	s in the tables b se price and expensions and expensions of the tables of the tables of the tables of tabl	Capital Cost for Functional Unit (\$) \$63.67 \$70 \$3.31	End-use Product cility of the size and depreciation purpos s. Do not include rec ed if desired. Commerical Ben CapEx Caregory Process Equipment Nonprocess	(lecility product.) (lecility production ses), For financed coverable "working chmark Technolog Examples furnaces, reactors	y-Capital Expenses (Co Capital Expense Kens : (deropional Evaporative condensees (Horal) Piping	Purchase Price (\$) \$1,000,000 Process Eq	Expected Equipment Lifetime (years) 25 uipment Total: 35	Annual Capital Cost for Facility (8) 140.000 91,423 428.57	Annual Capital Cost (\$) \$40,000 \$1,429 \$1,429 \$1,429 \$40,000	for Functional Unit (3) \$109.59 \$100.59 \$100.
Luse Product both the ne ime indicate ipment, cali ital* expens efault value w Technolog wEx Category cess ipment	tt. [flacity product.] We technology (left) an ed above. For each it ed above. For each it culate and include th es. of 5% of CapEx annue gy-Capital Expenses ; Esiamples furnaces, reactors piping, control systems_power equipment engineering, engineering,	(unite) (unite	rk (right), list ca pense and estimative spaces belo ial equipment ar Purchase Price (\$) \$254,306 \$50,000 \$50,000 kon-Process Equipment \$10,000	apital expense ate the purchas ate the purchas to list refere nd facility main Expected Equipment Interne (years) 10 10 10 10 10 10 10 10 10 10 10 10 10	s in the tables b se price and expensions, assumption intenance. This vo Annual Capital Cost for Facility (8) \$25,431 \$1	Iterime (for mis and calculation alue may be adjust for Functional Unit (\$) \$63.67 \$730 \$3.31 \$44 \$44 \$48.83	End-use Product clifty of the size and depreciation purpore, s, Do not induce rec ed if desired, Commerical Ben CagEin Calegory Registerint Nonprocess Equipment	Charley product) (Jackey product) typyjed production test, For financed coverable Norking Examples furnaces, reactors pping, control pystems, pover	y-Capital Expenses (Co Capital Expense Kens : (deropional Evaporative condensees (Horal) Piping	apEx) Purchase Price (\$) \$1,000,000 Process Eq \$50,000	Expected Equipment Lifetime (years) 25 uipment Total: 35	Annual Capital Cost for Facility \$40,000 00 \$40,000 00 \$40,000000000000000000000000000000000	Annual Capital Cost (\$) \$40,000 \$1,429 \$1,429 \$1,429 \$40,000	for Functional Unit (3) \$109.59 \$100.59 \$100.

The two tabs in the Economic Considerations category house economic operations data on the project.

	(facility product.)	(units)							(facility product.)	(units)		
equipment, calcu	late and include the	nd commercial benchma em listed, name the exp e cost of financing. Use	erk (right), list c bense and estim the spaces belo	apital expense late the purcha ow to list refere	s in the tables b ise price and exp ences, assumptio	elow. Consider a pected lifetime (i ons and calculati	facil for de	ity of the size and preciation purpos Do not include rec	typical production es). For financed overable *working			
capital* expense	5.											
A default value o	of 5% of CapEx annua	ally is assumed for annu	al equipment a	nd facility main	ntenance. This v	alue may be adju	usted	if desired.				
New Technology	- Capital Expenses	(CapEx)						Commerical Ben	chmark Technology	- Capital Expenses (Ca	pEx)	
		Capital Expense Items	Purchase	Expected Equipment Lifetime	Annual Capital Cost for Facility	Capital Cost for Functional			F 1	Capital Expense Items	Purchase	Expected Equipment Lifetime
CapEx Category	Examples	(descriptions) Waste Heat Recovery	Price (\$)	(years)	(\$)	Unit (\$)		CapEx Category	Examples	(descriptions) Evaporative	Price (\$)	(years)
		System (e.g. IHP)	\$254,306	10	\$25,431	\$69.67		_		condensers (4 total)	\$1,000,000	2
Process Equipment	furnaces, reactors							Process Equipment	furnaces, reactors			
Equipment	~							Equipment				
					105 101	170		7				
	1	Piping	\$50,000	uipment Total: 35	\$25,431 \$1,429	\$70 \$3.91				D: :	Process Eq \$50,000	uipment Tota
Non-process	piping, control	Piping	\$50,000	35	\$1,423	\$3.31		Nonprocess	piping, control	Piping	\$50,000	3
Equipment	systems, power							Equipment	systems, power			
	equipment		-						equipment.			
			Non-Process Eq	uipment Total:	\$1,429	\$4					Non-Process Eq	uipment Total
	engineering,	Design	\$10,000	15	\$667	\$1.83			engineering,	Design	\$10,000	2
Engineering &	design,	Installation	\$127,153	15	\$8,477	\$23.22		Engineering &	design,	Installation	\$500,000	2
Construction	procurement,							Construction	procurement,			
	construction								construction			
	1	Engi	neering & Cons	truction Total:	\$9,144	\$25				Engi	neering & Cons	truction Total
	land,								land,			
Other CapEx	commissioning,							Other CapEx	commissioning, contingency, spare			
	contingency								parts.			
	<u>.</u>		Othe	er CapEx Total:							Othe	er CapEx Total
				pital Expense:	\$36,003	\$98.64						pital Expense
1		Equipment/Facility M	aintenance (tvn	ical value 5%)-	5%	5%			Annual Canita	Equipment/Facility M	aintenance (tvn	ical value 5%
	Full Entry Rapid Home Page Home	Data Entry Project Bas Page Benchmar		Functional Unit	and the second	lanufacturing hergy	Use		OpEx Unit Conversion	100 000 000 000 000 000 000 000 000 000	mmary Resi bles Dast	ults nboard
canding rage 1	iomerage inome	berchman	12	STOL	toramentata D	12183	LUE	161	souve/sion	Guatomization IIa	Dasi	rboai u

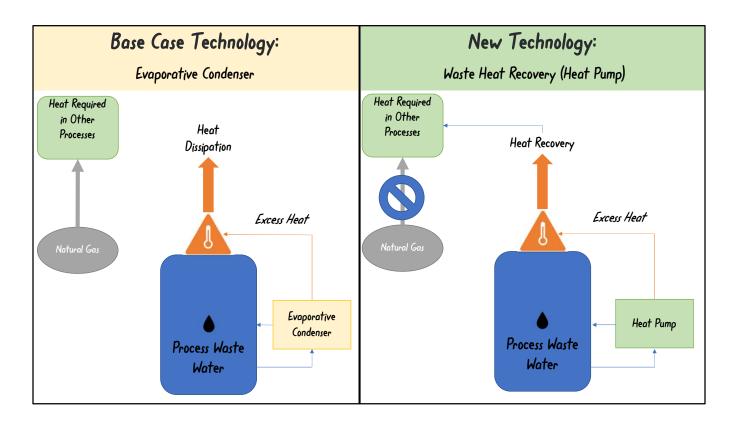
The CapEx (or capital expenses) tab captures the expenses for manufacturing equipment along with other purchase costs required to produce these technologies at the established scale.

		neuristic	TUOI TOT EAT	Chada Tash		UTECT)						ENERGY
In this tab, you will estimate operati	Expenses (OpE)				lologies (TEC	HIESI)				Blue Cells: User input		ENERGT
		()	<u>Return to</u>	o Planning Page						numerical Yellow Cells: User inp dropdown	ut - select from	Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
	tabs and data are rep of this tab. In estimat	produced here fo tes, consider the	or convenience (entri e annual costs for a f	es may be edited direc	tly in the Raw Materi	ark (right). Operating expenses include labo als and Manufacturing Energy tabs if edits a . The reference production quantities (as en	re needed). You will enter d	ata only for labo	r and (optional)	Purple Cells: Default of EIA sector averages or assumptions (can be us more specific data are Other Cells: Not inten	standard ser modified if available)	
	New Technology (a	t Industrial Sca	le)				Commercial Benchmark					1
Technology Name	Waste Heat Recove	ry (Heat Pump)	-			Technology Name	Evaporative Condenser					
Specific Product	Cooled Waste Wate	or				Specific Product	Cooled Waste Water					
Reference Production Quantity	2.00	Million Gallons	·			Reference Quantity	2.00	Million Gallons				
Annual Facility Production Quantity	730.00	Million Gallons				Annual Facility Production Quantity	730.00	Million Gallons				
employees and annual pay rates. If The default percentage for fringe be	data are available as a nefits and general over humb based estimatio	total annual lat rhead is 72% (co on methods may	bor cost instead, data considered a typical v	a may be entered direc alue) but this can be o	ctly in the "Labor Cost verwritten if needed.	he CapEx tab. By default, annual costs are of (\$) (per year)" column, over-writing the defa culator that will aid you in completing this s	ult formulas. Do not include					
New Technology - Direct Labor Costs						Commercial Benchmark - Direct Labo	r Costs					
	Number of FTE	Average Annual Pay	Employee Fringe Benefits & General	Annual Labor Cost (\$) (for facility of size	Labor Cost (\$) (per reference			Average Annual Pav	Employee Fringe Benefits & General	Annual Labor Cost (\$) (for facility of size	Scaled Annual Labor Cost (\$) (adjusted to new	Labor Cost (\$) (per reference
	Employees	Rate	Overhead Rate (%)	shown above)	quantity)		Number of FTE Employees	Rate	Overhead Rate (%)	shown above)	tech, facility size)	quantity)
Direct Labor (equipment operators & supervisors)		\$75,000	72%	\$1,240	\$3.40	Direct Labor (equipment operators & supervisors)	0.0332	\$75,000	72%	\$4,279	\$4,279	\$11.72
		Total Op	erating Labor Cost:	\$1,240	\$3.40			Total Op	erating Labor Cost:	\$4,279	\$4,279	\$11.72
				730 Million Gallons (Annual Facility Production)	2 Million Gallons (Reference Quantity)					730 Million Gallons (Annual Facility Production)		2 Million Gallons (Reference Quantity)
											Equivalent)	
Raw Materials Costs Materials costs entered into the "Ra New Technology - Raw Material Inpu		printed here for	r convenience. If data	a need to be adjusted,	make changes in the	Raw Materials tab. Commercial Benchmark - Raw Materi					Equivalent)	

The OpEx (or operating expenses) tab models the ongoing cost of operating the manufacturing equipment, through a measure of labor costs and other dynamic cost considerations.

Manufact	iring Cost Results					Cost Comparison II U.S. Market)
	Cost Comparison lent Reference Quantity		r	1	Hypothetical (Fully Deployed)	Current (Pre-Deployment)
Based on Equiva	ient Reference Quantity		New Technology, at Industrial Scale	Commercial Benchmark	Hypothetical Production:	Replaced Production:
		Technology Name	Waste Heat Recovery (Heat Pump)	Evaporative Condenser	7,300,000 Million Gallons \$461 million	7,300,000 Million Gallons \$1,109 million
		Reference Quantity	2 Million Gallons of Cooled Waste Water	2 Million Gallons of Cooled Waste Water		
			Manufacturing Cost (\$) for F			-
	Process Equipment		\$69.67			Labor Costs:
Capital Expense	Non-process Equipment		\$3.91	27-2-20		E\$#2292358
(CapEx)	Engineering & Construction	1	\$25.05	\$55.89		
	Other Capital Expenses					
	Facility & Equipment Mainte	enance	\$4.93	1. State 1.		CapEx Costs:
	Raw Materials		\$14.04			5681,660,000
Operating	Energy		\$0.18			
Expenses (OpE)			\$3.40		Labor Costs:	
	Other Recurring Costs		\$13.70		\$12,403,846	
Total	CapEx Subtotal		\$108.75			5 C
Manufacturing Cost	OpEx Subtotal Total Cost (CapEx + Op	Ex)	\$31.32		CapEx Costs:	Raw Materials Costs:
					Raw Materials Costs: \$\$1,246,000	\$355,680,976
					Waste Heat Recovery (Heat Pump)	Evaporative Condenser
					Other Costs Labor Costs Energy Costs CopEx Costs Raw Materials Costs	Summery Result

Finally, the two Results tabs will showcase the results of your TECHTEST analysis, in table form in the Summary Tables tab and graphically in the Results Dashboard tab. Now that the general TECHTEST framework has been established, let's get started with our example scenario.



For this example, we will use the Full Analytical Approach to analyze a new waste heat recovery technology involving a heat pump being used to cool process wastewater and compare it to the benchmark technology of using evaporative coolers to achieve the required heat removal. The heat recovered by the heat pump can be utilized upstream for process heating needs, offsetting natural gas purchases that would otherwise be required.

Techno-economic, El	nergy & Carbon Heuristic Tool for Ea	arly Stage Tech	nologies (TECHTE	EST)		ENERGY		
						Office of ENERGY EFFICIENCY &		
	Return to Full Entry Home Page	Retu	rn to Rapid Data Entry Ho	me Page		RENEWABLE ENERGY		
Project & Technology	Description							
Project Title	Waste Heat Recovery Cooling in Beverage Ma	anufacturing						
Lead Organization	Hypothetical Organization							
Collaborative Partner(s)	Staff							
Principal Investigator Name	John Doe							
Principal Investigator Organization	Hypotentical National Laboratory							
AMO Technology Manager	Jane Doe							
Project Start	January-23							
Project End	January-25							
Funding Mechanism	R&D Project							
	Emissions & Cost Impact Drive	/	Note: This see		ACTOR INCOMPLETE	ons over the	entire lif	ecycle
Energy & Emissions Impacts by Life Cycle Phase	In your opinion, would this technology be energy and/or emissions associated	likely to impact the	Note: This see Yes/No	Mec	hanism	ons over the		
Energy & Emissions Impacts	In your opinion, would this technology be	ikely to impact the with		Mec	hanism			
Energy & Emissions Impacts	In your opinion, would this technology be energy and/or emissions associated	ikely to impact the with		Mec	hanism			
Energy & Emissions Impacts	In your opinion, would this technology be energy and/or emissions associated raw materials used in the manufacturir	iikely to impact the with g process?		Mec	hanism			
Energy & Emissions Impacts by Life Cycle Phase	In your opinion, would this technology be <u>energy and/or emissions</u> associated raw materials used in the manufacturin manufacturing the end-use product? using, transporting, or disposing of the	iikely to impact the with ag process? end-use product?		Mec	hanism			
Energy & Emissions Impacts	In your opinion, would this technology be <u>energy and/or emissions</u> associated raw materials used in the manufacturin manufacturing the end-use product?	iikely to impact the with Ig process? end-use product? iikely to impact the		Mec (Expla	hanism			
Energy & Emissions Impacts by Life Cycle Phase Manufacturing Cost Impacts	In your opinion, would this technology be <u>energy and/or emissions</u> associated raw materials used in the manufacturin manufacturing the end-use product? using, transporting, or disposing of the In your opinion, would this technology be I	iikely to impact the with Ig process? end-use product? iikely to impact the	Yes/No	Mec (Expla	hanism in why this techr			
Energy & Emissions Impacts by Life Cycle Phase Manufacturing Cost Impacts	In your opinion, would this technology be <u>energy and/or emissions</u> associated raw materials used in the manufacturin manufacturing the end-use product? using, transporting, or disposing of the In your opinion, would this technology be <u>manufacturing costs</u> associated with .	iikely to impact the with Ig process? end-use product? iikely to impact the	Yes/No	Mec (Expla	hanism in why this techr			
Energy & Emissions Impacts by Life Cycle Phase Manufacturing Cost Impacts	In your opinion, would this technology be <u>energy and/or emissions</u> associated raw materials used in the manufacturin manufacturing the end-use product? using, transporting, or disposing of the In your opinion, would this technology be I <u>manufacturing costs</u> associated with . capital equipment?	iikely to impact the with Ig process? end-use product? iikely to impact the	Yes/No	Mec (Expla	hanism in why this techr			
Energy & Emissions Impacts by Life Cycle Phase Manufacturing Cost Impacts	In your opinion, would this technology be <u>energy and/or emissions</u> associated raw materials used in the manufacturin manufacturing the end-use product? using, transporting, or disposing of the In your opinion, would this technology be <u>manufacturing costs</u> associated with capital equipment? raw materials used in manufacturing? energy used in manufacturing? Project Bacies & abor?	iikely to impact the with Ig process? end-use product? iikely to impact the	Yes/No Yes/No	Mec (Expla	hanism in why this techr			

In the Project Basics & Benchmarks tab, we will identify where improvements may occur with respect to the new technology. The data input sections of this tab include: general project information; the generic market end-use product; definitions of competing technologies and products; and the energy, emissions, and cost impact drivers.

*	ergy & Carbon Heuristic Tool for E	arly Stage	Technologie	s (TECHTEST		ENER	
						Office of ENERGY DENEWA	EFFICIENCY & ABLE ENERGY
	Return to Full Entry Home Page		Return to Rapid	Data Entry Home P	age	The first of the second s	
Project & Technology	Description						
Project Title	Waste Heat Recovery Cooling in Beverage M	anufacturing					
Lead Organization	Hypothetical Organization						
Collaborative Partner(s)	Staff						
Principal Investigator Name	John Doe						
Principal Investigator Organization	Hypotentical National Laboratory						
AMO Technology Manager	Jane Doe						
Project Start	January-23						
Project End	January-25						
Funding Mechanism	R&D Project						
Generic Market End-Use Product*	* Cooled Waste Water * The "generic" market end-use product should be	defined generally	enough to encompas	ss the end-use produc	ts of all compet	ing technologies (new t	technology, commercial benchmark,
Generic Market End-Use Product ¹	Cooled Waste Water						
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products	s are different but		ve the same function	Specific differ	ences in the end produc	cts or applications can be specified
	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products	s are different but	would be used to ser	ve the same function	Specific differ	ences in the end product	cts or applications can be specified
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products	s are different but	would be used to ser	ve the same function	Specific differ Specific Pr Identify the	ences in the end produc	cts or applications can be specified
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products	s are different but	would be used to ser	ve the same function	Specific differ Specific Pr Identify the	ences in the end produc oduct or Application end-use products applications for this	ts or applications can be specified Technology Status Is this technology a current typical
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products	s are different but	would be used to ser	ve the same function	Specific differ Specific Pl Identify the and/or key	ences in the end produc oduct or Application end-use products applications for this	Technology Status Is this technology a current typical technology, a state-of-the-art
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products	s are different but	would be used to ser Technology Defini Define the technolo	ve the same function	Specific differ Specific Pr Identify the and/or key technology, differences	ences in the end produc oduct or Application end-use products applications for this	Technology Status Is this technology a current typical technology, or an emerging
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products in the table below.	s are different but	would be used to ser Technology Defini Define the technolo	ve the same function ition very (Heat Pump)	Specific differ Specific Pr Identify the and/or key technology, differences Cooled W	ences in the end product oduct or Application end-use products applications for this noting any	Technology Status Is this technology a current typical technology, or an emerging technology, or an emerging technology?
Definitions of Competing	Cooled Waste Wate * The "generic" market end-use product should be other competing technologies), if the end product in the table below.	s are different but	would be used to ser Technology Defini Define the technolo Waste Heat Reco	ve the same function ition very (Heat Pump)	Specific differ Specific Pr Identify the and/or key technology, differences Cooled W	ences in the end product oduct or Application end-use products applications for this noting any asfe Water	Technology Status Is this technology a current typical technology, a state-of-the-art technology, or an emerging technology? Typical Technology
Definitions of Competing	Cooled Waste Water * The "generic" market end-use product should be other competing technologies), if the end products in the table below. New Technology (developed in this project) Commercial Benchmark Technology	s are different but 1	would be used to ser Technology Defini Define the technolo Waste Heat Reco	ve the same function ition very (Heat Pump)	Specific differ Specific Pr Identify the and/or key technology, differences Cooled W	ences in the end product oduct or Application end-use products applications for this noting any asfe Water	Technology Status Is this technology a current typical technology, a state-of-the-art technology, or an emerging technology? Typical Technology

We will enter the end-use product as "cooled waste water," defining the new and commercial benchmark technologies as "Waste Heat Recovery (Heat Pump)" and "Evaporative Condenser," respectively.

	OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (EER & Carbon Heuristic Tool for Early Stage T		ENERGY
			Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
Re	turn to Full Entry Home Page	Return to Rapid Data Entry Home Pa	RENEWABLE ENERGY
Project & Technology Des	cription		
Project Title	aste Heat Recovery Cooling in Beverage Manufacturing		
Energy, Emis	ssions & Cost Impact Drivers	Note: This section	examines emissions over the entire lifecycle
Energy & Emissions Impacts	In your opinion, would this technology be likely to impact		Mechanism
by Life Cycle Phase	energy and/or emissions associated with	Yes/No	(Explain why this technology would be likely to have an impact.)
	raw materials used in the manufacturing process?	Yes	Higher energy efficiency, no cooling water needed
	manufacturing the end-use product?		
	using, transporting, or disposing of the end-use product	17	
Manufacturing Cost Impacts by Cost Component	In your opinion, would this technology be likely to impact i manufacturing costs associated with	the Yes/No	Mechanism
	capital equipment?		
	raw materials used in manufacturing?		
	energy used in manufacturing?		
	manufacturing labor?		
Impacts by Sector	In your opinion, would this technology be likely to impact following sectors (energy, emissions, or cost)?	the Yes/No	Mechanism
For each sector that would be impacted	Mining	Yes	Used to save energy in beverage manufacturing
by the new technology, briefly describe the <u>mechanisms</u> of potential impacts.	Manufacturing		
(Assume successful commercializatio and adoption.)	¹ Transportation		
anu auopuon.)	Energy Generation (utility scale)		
	Energy Generation (device scale)		

We then identify the areas where the new technology could see improvements over the benchmark.

	Return to Planning Page	2		Office of ENERGY EFFICIENCY &
Market Size				RENEWABLE ENERGY
Annual U.S. Production of End-use	Product: 7,300,000	Million Gallons	of (end-use p	roduct not yet defined) pe
	(all U.S. production, all facilities)	(units)	aust of cooled waste	water produced at 10,000
Market Breakdown			nationwide over 365	
			Pre-Deployment	Full Deployment
				Market Share (%):
References, Notes, and Ass	umptions			
	<u> </u>			
List key references and assumptions used to prepare the data provided in this sheet. Add				
as many rows as needed.				
as many rows as needed.				
as many rows as needed.				
as many rows as needed.				
as many rows as needed.				
Calculations	ations and datailed references supporting the data	a shove Add as many rows	as needed	
Calculations	ations and detailed references supporting the data	a above. Add as many rouse	as needed	
Calculations	lations and detailed references supporting the data	a above. Add as many rows	as needed.	

On the Market tab, we input the total annual production of the end-use product at all U.S. facilities (in this case, the amount of cooled waste water produced at 10,000 towers nationwide over 365 days), as well as the hypothetical use percentages for each technology. There is also space to add references, notes, assumptions, and calculations; this space appears at the bottom of each data input tab.

A Functional Unit defines the quantity of a product or product system bas accurate comparisons (of environmental or cost metrics) for disparate proc	Return to Return to choosing a f youtube.com/v ed on the perfo lucts or system penchmark te	Planning Page iunctional un vatch?v=6 5j8kT ormance it deliv s that serve the chnology. The	it can be found in formOo&ab channel=L vers in its end-use ap e same final function process can be brok	D.S.Departmen oplication. The . The function en down into	tofEnergy purpose of al unit can two steps	defining a perform be used to objecti	nance-base		Cilitate to the
Step 1. Dased on the functional unit, specify a feferer		The second se	nchmark Techr		De com		quivalent refer	chee quan	inty for the
Use the functional unit to s	pecify a product	tion reference o	uantity for the new t	echnology, as	shown in t <mark>h</mark>	e examples below	0.		
Functional Unit Based Reference Quantity for the New Technology:	2	Million ga	llons of	f Cooled We	aste Water	for New T			
	value Examples:	80 kg of new eth 1,000,000 lume 9 kg of dual-pha	init inlene catalyst in-hours produced by a n se high strength steel mer pallet shipping palle		gn		Note: the f and referen are the ba	nce quai sis of	ntity
Finally, specific the performance-equivalent production reference quantity for th for the new technology. It depends on how you've defir								for The	enTire
Performance Equivalent Reference Quantity for the Commercial Benchmark:	2 Value	Million gallo	ns of	f Cooled h	laste Wate	for Comm	ercial Benchmark Tech	nology	
	Examples:	90 kg of conven	tional ethylene catalyst						
	Functiona	13 kg of conventional	wood stringer pallets				Critter		Decilie
TECHTEST Full Entry Home Page Home P	Uni	Raw Materials	Manufacturing Energy	Use Phase Energy	CapEx 0	pEx Unit Conversion	Grid Mix Customization	Summary Tables	Results Dashboard

On the Functional Unit tab, we establish 2 million gallons of cooled waste water (the typical daily output of a water tower) as our reference quantity. Despite differences in the process, both technologies will produce the same amount of water, so our equivalent reference quantity stays the same.

Note that the functional unit, and reference quantity, are the basis of comparison for the entire assessment, so it is important to ensure consistency between the new and benchmark technologies. If you are unfamiliar with establishing a functional unit, we recommend viewing the "Defining Functional Units" tutorial video, linked at the top of the Functional Unit tab.

	U.S. DEPARTMENT OF EN													
Lite (vcle Imnact	Techno-economic	, Energy & Ca	arbon Hei	uristic Tool f			ogies (TECH	TEST)						
Life Cycle Impacts Raw Materials	Raw Material Eml	e the embodied e	energy, emb	odied carbon, ar	nd cost for raw ma	terial inputs to r				mmercial Benchmark (right).				
		utilities are imported by default from the Benchmarking section of the "Project Basics" tab; and reference quantities are imported from the "Functional Unit" tab. If any edi arried through entire analysis. New Technology (at Industrial Scale)										Commercial Benchmark		
	Technology Name	Waste Heat Reco		np)						Technology Name	Evaporative Condenser			
	Specific Product	Cooled Waste Wa	200 1000000 0000000000							Specific Product	Cooled Waste Wat		100	
Contribute to:	Reference Quantity	2.00	Million Gallo	ns						Reference Quantity	2.00	Million Ga	llons	
Dollar Cost		(quantity)	(units)								(quantity)	(units)		
 Energy Use CO2 Emissions 		on for input materia stimates (or other s on results can then	als may conver ources and as be pasted as	niently be estimate sumptions) in the * values in the Speci	d using NREL's Ma References, Notes,	terials Flow Thro and Assumption	ugh Industry (MFI)	tool (using the exact m	aterials if availab	o racilitate comparisons. ile, or using similar *proxy* m easily extract embodied ener				
Can include: • Ingredients • Materials	New Technology - Raw M	laterial Inputs		Enter MFI embodied energy data in this column 4	Enter MFI embodied carbon data in this column 4								Enter MFI embodied ener Enter MFI embo energy data in column (if applic	
 Materials Relevant Machinery 	Material Inputs (list)	Amount of Materi (to produce referen quantity)		Specific Embodied Energy (Btu/unit) (for this material)	Specific Embodied Carbon (lbs CO2- eq/unit) (for this material)	Specific Cost (\$/unit) (for this material	Embodied Energy (MMBtu) (per reference) quantity of product	CO2-eq) (per reference quantity of	(per reference	Material Inputs	Amount of Materia (to produce referenc quantity)	d.	Specific Embo Energy (Btu/u (for this mater	
										(#55)	quantity	Unic	(for this mate	
	**		-							-				
	*The IPA team defines *em independently, the latest II Reference Data: 100-Yea	PCC data for GWP a	nd combustion	the 10-year Global nemissions factors		(GWP) of green			material's extract	ion, processing, and manufac	turing. IPCC 2013 (AF	95) data are	Total emb used for 10-ye	
TECHTEST Full Entry Rapid Data Ent anding Page Home Page Home Page	ry Project Basics & Benchmarks		⁻ unctional Jnit	Ruw Male Jals	Manufact Energy		Use Phase Energy	CapEx OpEx	Unit Conversio	Grid Mix n Customization	Summary Tables	Resul Dasht		

Next, we'll work through the Life Cycle Impacts category, starting with raw materials. The Raw Materials tab compiles data on the materials required to produce the identified reference quantity of each technology. These materials contribute to the overall dollar cost, energy use, and emissions. Raw materials can include product ingredients, materials, and relevant machinery, but will vary significantly based on technology and project scope.

				Enter MFI embodied energy data in this	Enter MFI embodied carbon data in this				
				column	column				
	New Technology - Raw Ma	aterial Inputs		4	4				
		Amount of Material		Specific Embodied	Specific Embodied Carbon (lbs CO2-	Specific Cost	Embodied Energy (MMBtu)	Embodied Carbon (lbs C02-eq)	Cost (\$) (per reference
	Material Inputs (list)	(to produce reference quantity)	unit	Energy (Btu/unit) (for this material)	eq/unit) (for this material)	(\$/unit) (for this material)	(per reference quantity of product)	(per reference quantity of product)	quantity of product)
	Lubrication					\$6.00	0.2	"	\$14
No. Talada	Copper	l. This tab	mov	he left hl	nnl		0.0	1	\$0
New Technology:	Elus I onner		may			0.0	1	\$0	
Heat Pump	HDPE						0.0	0	\$0
neur rump	Low Alloyed Steel						0.0	0	\$0
	Lubricating Oil (Mf						0.0	0	\$0
	PVC	1	rg 🚬	t <u>en</u> t			0.0	0	\$0
	Reinforced Steel		<u>ca ribi</u>				0.0	2	\$0
Reference Quantity	7	L							
Ner er ence addingry						r input materials:	0.3 MMBtu	15 lbs CO2-e	\$14
=		2. Cost of	r01./ 11	naterials a	f		0.0111010	10 103 007 0	
• • • • •									
2 Million Gallons	Commercial Benchmark	machine	ry sho	uld NOT	be				
			'			Specific Cost	Embodied Energy (MMBtu)	Embodied Carbon (lbs CO2-eq)	Cost (\$) (per reference
	Material Inputs	included				(S/unit)	(per reference	(per reference quantity of	quantity of
	(list)	llachu	da ia Ca	p ex Tab)		(for this material)	quantity of product)	product)	s3Y
P I I	<u>City Water Supply</u> Biocide for Micro Cont	(inclus					0.0	0.044	\$63
Benchmark:	Steel Low Alloy					\$19.09	0.0	0	\$0
Evaporative	Stainless Steel	0.350	kg	53,741	6.2		0.0	2	\$0
•	Aluminum	0.399	kg	146,912	9.2		0.1	Ý	\$0
Condenser	Bricks	0.346	bricks	2,843	0.2		0.0	0	\$0
	Methacrylate	0.288	kg	110,080	5.9		0.0	2	\$0
	Polyurethane	0.026	kg	68,338	3.8		0.0	0	\$0
		0.495	kg	73,172	3.1		0.0	2	\$0
	PVC	0.115							

For this example, we have assembled a list of the materials required to build the technology in question, along with materials that are consumed when running these machines. The machine-part materials are amortized across the lifetime of the machine (with their costs included later in the capital expenses tab), and all inputs are calculated on a per reference quantity basis. Next, embodied energy and embodied carbon values are entered for each raw material, as well as the monetary cost of the materials consumed when running these machines.

There are a few important points to keep in mind for this section:

First, this tab may be left blank for a technology that is process-focused, as raw materials contributions may not be significant in such cases.

Second, the cost of raw materials of machinery should NOT be included, as the total machinery cost will be identified later in the CapEx tab.

·····				Return to P	lanning Page							
.ife Cycle Impacts: 1anufacturing Energy	Manufacturing	Energy, Emissions, and	I Energy Co	sts								
ianaracranny Energy	Estimate onsite energy of	Estimate onsite energy consumption (in the blue input cells) by energy/tuel type. Energy consumption totals should correspond to the reference quantity of finished pr										
	the new technology (left)	and commercial benchmark technol	ogy (right) to facilita	ate comparisons.	. Default data are pro	ovided for energy prices, GW	/P, and source-to-s					
		tab) and can be user-adjusted from					alues for 100-Yea					
	associated with energy o	onsumption. See the GWP & Combu	tion Data tad (link)	ed below) for sol	Irce data and assump	otions.						
		New Technology (at Indust	rial Scale)									
	Technology Name	Technology Name Waste Heat Recovery (Heat Pump)										
	Specific Product	Specific Product Cooled Waste Water										
	Reference Quantity	2.00	Million Gallons	Million Gallons								
		(quantity) (units)										
		New Technology - Energy Consumption & Cost Data (to produce reference quantity)										
	New Technology - Ene	rgy Consumption & Cost Data (to produce refer	ence quantity)								
	New Technology - Ene	rgy Consumption & Cost Data (Data entry	Default sector	data* (Can be modif	fied if needed. If modifying						
	New Technology - Ene			Default sector			1					
	New Technology - Ene	Energy Source	Data entry ↓	Default sector	data* (Can be modif ue, change backgrour	nd color to blue)	Primary Energy					
	New Technology - Ene	Energy Source (Dropdowns available for	Data entry ↓ Onsite Energy	Default sector valu	data* (Can be modif ue, change backgrour Specific 100-yr	Source-to-Site Ratio	Consumption,					
	New Technology - Ene	Energy Source	Data entry ↓	Default sector	data* (Can be modif ue, change backgrour	nd color to blue)	Consumption,					
		Energy Source (Dropdowns available for Petroleum, Coal, and	Data entry Unsite Energy Consumption*	Default sector valu	data* (Can be modif ue, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu)	nd color to blue) Source-to-Site Ratio (electricity and steam only)	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable)	Data entry Unsite Energy Consumption*	Default sector valu Specific Price (\$/MMBtu)	data* (Can be modif ue, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu)	nd color to blue) Source-to-Site Ratio (electricity and steam only)	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity	Data entry Unsite Energy Consumption*	Default sector valu Specific Price (\$/MMBtu) \$21.04	data* (Can be modif e, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable)	Data entry Unsite Energy Consumption*	Default sector valu Specific Price (\$/MMBtu)	data* (Can be modif e, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas Renewable	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity Natural Gas	Data entry Unsite Energy Consumption*	Default sector valt Specific Price (\$/MMBtu) \$21.04 \$5.79	data* (Can be modif ie, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86 1.00	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas Renewable Steam	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity	Data entry Unsite Energy Consumption*	Default sector valu Specific Price (\$/MMBtu) \$21.04	data* (Can be modif ie, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86 1.00	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas Renewable Steam Custom Input 1	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity Natural Gas	Data entry Unsite Energy Consumption*	Default sector valt Specific Price (\$/MMBtu) \$21.04 \$5.79	data* (Can be modif ie, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86 1.00	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas Renewable Steam Custom Input I Custom Input II	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity Natural Gas	Data entry Unsite Energy Consumption*	Default sector valt Specific Price (\$/MMBtu) \$21.04 \$5.79	data* (Can be modif ie, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86 1.00	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas Renewable Steam Custom Input 1	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity Natural Gas	Data entry Unsite Energy Consumption*	Default sector valt Specific Price (\$/MMBtu) \$21.04 \$5.79	data* (Can be modif ie, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86 1.00	Consumption, including offsite losses (MMBtu)					
	Fuel or Energy Type Electricity Petroleum Coal Natural Gas Renewable Steam Custom Input I Custom Input II	Energy Source (Dropdowns available for Petroleum, Coal, and Renewable) Electricity Natural Gas	Data entry	Default sector valt Specific Price (\$/MMBtu) \$21.04 \$5.79	data* (Can be modif ie, change backgrour Specific 100-yr GWP (Ib C02-eq / MMBtu) 108.6	nd color to blue) Source-to-Site Ratio (electricity and steam only) 2.86 1.00	Consumption, including offsite losses (MMBtu)					

The Manufacturing Energy tab calculates the energy required to "manufacture" the reference quantity.

			1	Energy So	urce			Onsi	te Energy		
		(Drop	downs	available	e for Pe	etroleu	ım, 🛛	Cons	umption	* S	pecific Pric
Fuel or Energy	Fuel or Energy Type		Coal, and Renewable)						Btu)	(§/MMBtu)
Electricity		Electr	icity								\$
Petroleum											
Coal	Asphal	t (bitum	en) and	road oil							
Natural Gas		& distilla									
Renewable	Kerose	ed Petrolo ne	eum Ga	S							
Steam	Motor	Gasoline									
Custom Input I		um Coke al Fuel O									
Custom Input II		etroleur									
Custom Input III											
	ct Basics & Market	Functional Unit	Raw Materials	Manufacturing Energy	Use Phase Energy	CapEx Op	Ex Unit		Grid Mix	Summary Tables	/ Results Dashboard

Energy sources can be selected from dropdown lists within the yellow cells.

rce	Onsite Energy			Source-to-Site Ratio
for Petroleum,	Consumption*	Specific Price	Specific 100-yr GWP	(electricity and steam
wable)	(MMBtu)	(\$/MMBtu)	(lb CO2-eq / MMBtu)	only)
		\$21.04	108.6	2.86
	-	\$11.14	188.3	1.00
		\$5.79	130.6	1.00
		\$4.70	146.4	1.20

Notice that the values in the purple cells automatically populate after you identify the energy sources in the dropdown.

Category	Energy Source	CO2 Emissions Factor (kg of GHG per TJ)	CH4 Emissions Factor (kg of GHG per TJ)	N2O Emissions Factor (kg of GHG per TJ)	Calculated 100-Year GWP Emissions (kg CO2-eg per TJ)	Calculated 100-Year GWP Emissions (Ibs C02-eq per MMBtu)*	
	Bitumen (asphalt)	80.700		0.6		188.3	
	Gas / Diesel Oil (distillate fuel oil)	74,100	3	0.6	74,345	172.9	
	Liquified Petroleum Gas	63,100	1	0.1	63,154	4 146.9	
Petroleum	Kerosene	71,900	3	0.6	72,145	167.8	
Fetroleum	Motor Gasoline	69,300	3	0.6	69,545	161.8	
	Petroleum Coke	97,500	3	0.6	97,745	227.4	
	Residual Fuel Oil	77,400	3	0.6	77,645	180.6	
	Other Petroleum	73,300	3	0.6	73,545	171.1	
	Coke Oven Coke and Lignite Coke	107,000	10	1.5	107,680	250.5	
Coal	Bituminous Coal	94,600	3	1.5	95,091	221.2	
Coal	Anthracite	98,300	3	1.5	98,791	229.8	
	Lignite	101,000	3	1.5	101,491	236.1	
Natural Gas	Natural Gas	56,100	1	0.1	56,154	130.6	
	Municipal Waste (biomass)	100,000	30	4.0	101,902	237.0	
Renewable Fuels	Industrial Wastes	143,000	30	4.0	144,902	337.0	
Iteliewable I dela	Wood / Wood Waste	112,000	30	4.0	113,902	264.9	
	Biogasoline & Biodiesel	70,800	3	0.6	71,045	165.3	
Steam	Steam and Hot Water**	62,872	1	0.1	62,936	146.4	

If necessary, you can customize the specific prices, global warming potentials, and source-to-site ratios by modifying these values in the GWP Ref Tables and EIA Ref Tables tabs. And remember, all energy cost inputs should be on a perfunctional-unit basis.

/P Emissions C02-eq) 5 Ib C02-e 7 Ib C02-e
5 lb CO2-e
' lb CO2-e
/ lb CO2-e
3 lb CO2-e
WP Emissions
) C02-eq)
b CO2-eq) 0.3 /b CO2-e
0.3 lb CO2-e
'e

For our example scenario, we enter the associated electricity and natural gas onsite energy consumptions for manufacturing both technologies, based on the 2-million-gallon reference quantity.

Manufacturin If there are <u>process en</u> If there are no significa	nissions asso ant process er	ciated with either nissions, leave th	the new technolog	y or commercial be				nissions and	1 associa	ated 100-yea	ar GWP belo	w. Do not incl
		ission Type		Amount emitted		. oranicj		ed 100-Year	Emi	bodied Carbo	n	1
Nov Tochool	(ch	emical name or a	(cronym)	(lb)	100-Year	GWP*	GWP	Cu 200-1001		CO2-eq)		
new recrimon	' ' 97' 💾	R-13		0.05		00			(10	64 lbs CC)2-e	1
New Technolo Heat Pump		<u></u>	19	0.03	1.3	~~				01100.00		1
rieur rump	י 											1
				1				To	tal:	64 lbs	(02-e	
			ues for 100-Year Gi		ential (GWP	P). See the (GWP Data					s for the mos
TECHTEST Full Entry Landing Page Home Page	Rapid Data Entry Home Page	Project Basics & Benchmarks	Market Functiona Unit	l Raw Mai Materials Ene	nufacturing rgy	Use Phase Energy	СарЕх	DpEx Unit Conver		id Mix Istomization	Summary Tables	Results Dashboard

In this tab, we will also enter the manufacturing process emissions (if applicable) that result from manufacturing the reference quantity. In this case, emissions associated with the refrigerant used in the new waste heat recovery technology are entered.

Use Phase Energy Use Phase Energy Expected impacts from the product's final use are quantified The change in total annual inergy consumption is alculated assuming the new technology reaches naximum market adoption vernight.	ife Cycle Impacts:	U.S. DEPARTMENT OF ENERGY (DOE) OFFICE OF ENERGY EFFICIENCY	AND RENEWABLE ENE	RGY (EERE)		Blue Cells: User input - text or numerical	
Control to the properties of the product is and product in the product is series of the finished product in the series of the finished product is series of the finished product in the series of the finished product is series of the finished product in the series of the finished product is series of the finished product in the series of the finished product is series of the finished product in the series of the finished product is series of the finished product in the series of the finished product in the series of the series		Techno-economic, En	ergy & Carbon Heuristic	Tool for Early S	tage Technol	ogies (TECHTEST)	Yellow Cells: User input - select from dropdown	
Control to the properties of the properties o	a Phose Energy		Return to Planning	Page				
 Aspected impacts from the construction of the provide section of the provide	e i nase bileryy	Use Phase Energy and	d Emissions				assumptions (can be user modified if more specific data are available)	
The change in total annual nergy consumption is alculated assuming the ew technology reaches maximum market adoption vernight.	roduct's final use are	savings (compared to typical materi technologies where the end-use no To evaluate the use phase energy in 1. Current Annual Energy Con 2. Hypothetical Annual Energy In the "Current" scenario, assume th	iab) when used in a vehicle; and an energy duct is identical to that produced using co uppact, estimate the <u>total U.S. annual energy</u> nsumption gy Consumption, Based on "Overnight Repl he current market size and market conditi	efficient device may pro rrent typical technologie <u>ty consumption</u> (for the e acement" with New Tech	wide electricity saving is. For example, a new end-use market impact	s (compared to typical devices) whe production route for a commodity c ed by the technology) based on two	en used in a consumer application. If hemical would <u>not</u> be expected to hi scenarios:	the technology is no ave use phase impac
alculated assuming the ew technology reaches maximum market adoption vernight.	•			industry-specific data a Default se	re available. Provide y ector data*	our references, assumptions, sourc Data entry**		
biculated assuming the ew technology reaches aximum market adoption vernight.	ergy consumption is			\downarrow	+			Annual Energy
sev technology reaches aximum market adoption vernight. Sector & Energy Type Energy Source / MMBiu) onsite) (fuel specific units) Specific Price (\$/MMBiu) Electricity Electricity 108.6 2.86 \$2.86 Petroleum Look Up Electricity 108.6 2.86 Petroleum Look Up Electricity 108.6 2.86 Pe	lculated assuming the				Ratio (Btu	Annual Energy Consumption		Annual P
Industrial Sector Industrial Sector Certricity Lectricity 108.6 2.86 \$\$21.04 Petroleum Look Up #N/A 1.00 #N/A Coal Look Up #N/A \$	w technology reaches	Sector & Energy Type	Energy Source				Specific Price (\$/MMBtu)	Consump
Coal Look Up #V/A 1.00 #V/A Natural Gas Natural Gas 130.6 1.00 \$V/A Renewable Look Up #V/A 1.00 \$V/A \$V/A Steam Steam and Hot Water* 146.4 1.20 \$4.70 Custom Input I Custom Input II	•		Industrial Sector					
Coal Look Up RN/A LOO RN/A Natural Gas Natural Gas 130.6 1.00 81/A Renewable Look Up \$\$\mathcal{R}\$\$ \$\$\mathcal{N}\$\$ \$\$\mathcal{R}\$\$\$ \$\$\mathcal{N}\$	ximum market adoption	Electricity	Electricity	108.6	2.86		\$21.	04
Natural Gas Natural Gas 130.6 1.00 \$5.79 Renewable Look Up #N/A 1.00 #N/A 1.00 #N/A Steam Steam and Hot Water* 1.46.4 1.20 \$4.70 \$4.70 Custom Input I Custom Input II Custom Input III Custom Input II Custom Input III Custom Input III	man wer wer were hilden							
Venewable (cost up File File <td>- aight</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	- aight							
Steam Steam and Hot Water* 146.4 1.20 \$4.70 Custom Input I Custom Input II Custom Input III	rugui.		Natural Gas					
Custom Input I Image: Custom Input II Image: Custom Input II Custom Input II Image: Custom Input II Image: Custom Input II	-		Steam and Hot Water*					
Custom Input II de			Steam and not water-	140.4	1.20		34.	10
			7					
Custom input III		Custom Input III						
	aximum market adoption	Electricity Petroleum Look Up Coal Look Up Natural Gas Renewable Look Up Steam Custom Input I Custom Input II	Industrial Sector Electricity Natural Gas	108.6 #N/A #N/A 130.6 #N/A	5 2.86 1.00 1.00 5 1.00 1.00		\$21. #N #N \$5. #N	/A /A 79 /A

The Use Phase Energy tab is where expected energy impacts from the product's final use are quantified for both the new and benchmark technologies. Because the use phase energy depends on the size of the end-use market, the change in total U.S. annual energy consumption is calculated assuming the new technology reaches maximum market adoption overnight.

		+					
					ual Energy & Emissions - Pro overnight replacement" with new t		
		Source-to-Site		(00300 011	vernight replacement with new t	comology)	
	Specific 100-yr	Ratio (Btu					
177 - 179533		primary / Btu	Annual Energy Consumption		Annual Primary Energy		Annual Associated GWP
Energy Source	/ MMBtu)	onsite)	(fuel specific units)	Specific Price (\$/MMBtu)	Consumption (MMBtu)	Annual Associated Cost (\$)	Emissions (tons CO2-eq)
Industrial Sector							
Electricity	108.6	2.86	108 130 193 MMRtu	\$21.04	309 182 690 MMRTU	\$2 275 424 343 79	5 870 785 tone (02-a
	#N/A	1.00	100,100,110 101010	#N/A			5,010,100 ,015 COL-E
	#N/A	2.00		#N/A			
Natural Gas	130.6	1.00	-222 771 704 MMBtu	\$5.79	-222 771 704 MMBtu	-\$1 290 746 544 34	14 548 652 tons (02-
	#N/A	1.00		#N/A			11,510,052 1013 005 0
Steam and Hot Water*	146.4	1.20		\$4.70			
	Default se	ector data*	Data entry**			Benchmark: l	vaporative
		fied if needed)	Data entry** ↓			Conde	evaporative nser
			Data entry** ↓		U.S. Energy & Emissions - Pr ased on current technologies in u	Conde oduct Use Phase	evaporative nser
	(can be modi ↓	fied if needed) ↓ Source-to-Site	Data entry** ↓		U.S. Energy & Emissions - Pr based on current technologies in u	Conde oduct Use Phase	evaporative nser
	(can be modi ↓ Specific 100-yr	fied if needed) ↓ Source-to-Site Ratio (Btu	4		U.S. Energy & Emissions - Pr assed on current technologies in u Annual Primary Energy	Conde oduct Use Phase	nser
	(can be modi ↓ Specific 100-yr GWP (lb CO2-eq	fied if needed) ↓ Source-to-Site Ratio (Btu primary / Btu	↓ Annual Onsite Energy	(8	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite	Conde oduct Use Phase	Annual Associated GWP
Energy Source	(can be modi ↓ Specific 100-yr	fied if needed) ↓ Source-to-Site Ratio (Btu	4		U.S. Energy & Emissions - Pr assed on current technologies in u Annual Primary Energy	Conde oduct Use Phase	nser
1	(can be modi ↓ Specific 100-yr GWP (lb CO2-eq	fied if needed) ↓ Source-to-Site Ratio (Btu primary / Btu	↓ Annual Onsite Energy	(8	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite	Conde oduct Use Phase	Annual Associated GWP
1	(can be modi ↓ Specific 100-yr GWP (Ib CO2-eq / MMBtu)	fied if needed) ↓ Source-to-Site Ratio (Btu primary / Btu onsite)	Annual Onsite Energy Consumption (MMBtu)	(8	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Indus	(can be modi ↓ Specific 100-yr GWP (Ib CO2-eq / MMBtu)	fied if needed) ↓ Source-to-Site Ratio (Btu primary / Btu onsite)	↓ Annual Onsite Energy	(t Specific Price (\$/MMBtu)	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite	Conde oduct Use Phase	Annual Associated GWP
Indus	(can be modi ↓ Specific 100-yr GWP (lb CO2-eq / MMBtu) strial Sector 108.6	fied if needed) ↓ Source-to-Site Ratio (Btu primary / Btu onsite) 2.86	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$/MMBtu) \$21.04	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Indus	(can be modi ↓ Specific 100-yr GWP (Ib CO2-eq / MMBtu) strial Sector 108.6 #N/A	fied if needed) Source-to-Site Ratio (Btu primary / Btu onsite) 2.86 1.00 1.00	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$/MMBtu) \$21.04 #N/A	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Electricity	(can be modi ↓ Specific 100-yr GWP (lb C02-eq / MMBtu) strial Sector 108.6 #N/A #N/A	fied if needed) Source-to-Site Ratio (Btu primary / Btu onsite) 2.86 1.00 1.00	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$/MMBtu) \$21.04 #N/A #N/A	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Electricity	(can be modi ↓ Specific 100-yr GWP (lb C02-eq / MMBtu) strial Sector 108.6 #N/A #N/A 130.6	fied if needed) Source-to-Site Ratio (Btu primary / Btu onsite) 2.86 1.00 1.00 1.00 1.00	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$//MMBtu) \$21.04 #N/A #N/A \$5.79	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Indus Electricity Natural Gas	(can be modi ↓ Specific 100-yr GWP (lb C02-eq / MMBtu) strial Sector \$\$\frac{108.6}{\$\$\pi N/A\$} \$\$\frac{\$\$\$\pi N/A\$}{\$	fied if needed) Source-to-Site Ratio (Btu primary / Btu onsite) 2.86 1.00 1.00 1.00 1.00	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$/MMBtu) \$21.04 #N/A #N/A #N/A \$5.79 #N/A	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Indus Electricity Natural Gas	(can be modi ↓ Specific 100-yr GWP (lb C02-eq / MMBtu) strial Sector \$\$\frac{108.6}{\$\$\pi N/A\$} \$\$\frac{\$\$\$\pi N/A\$}{\$	fied if needed) Source-to-Site Ratio (Btu primary / Btu onsite) 2.86 1.00 1.00 1.00 1.00	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$/MMBtu) \$21.04 #N/A #N/A #N/A \$5.79 #N/A	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
Indus Electricity Natural Gas	(can be modi ↓ Specific 100-yr GWP (lb C02-eq / MMBtu) strial Sector \$\$\frac{108.6}{\$\$\pi N/A\$} \$\$\frac{\$\$\$\pi N/A\$}{\$	fied if needed) Source-to-Site Ratio (Btu primary / Btu onsite) 2.86 1.00 1.00 1.00 1.00	Annual Onsite Energy Consumption (MMBtu)	(t Specific Price (\$/MMBtu) \$21.04 #N/A #N/A #N/A \$5.79 #N/A	U.S. Energy & Emissions - Pr ased on current technologies in u Annual Primary Energy Consumption, including offsite losses (MMBtu)	Conde oduct Use Phase (Annual Associated Cost (5)	Annual Associated GWP Emissions (tons CO2-eq)
	Industrial Sector Electricity Natural Gas	Industrial Sector 108.6 Electricity #N/A Natural Gas 1300 #N/A #N/A	Industrial Sector 108.6 2.86 BitVA 1.00 1.00 1.00 WA 1.00	Industrial Sector 108.6 2.86 108,130,193 MMBtu ZIV/A 100 2	Industrial Sector 108.6 2.86 108,130,193 MMBtu \$21.04 Electricity #N/A 1.00 #N/A 1.00 #N/A Matural Gas 130.6 1.00 -222,711,704 MMBtu \$5.79 Matural Gas #N/A 1.00 -222,711,704 MMBtu \$8.79	Industrial Sector 108.6 2.86 108,130,193 MBHu \$21.04 309,182,690 MMBTU #N/A 1.00 #N/A #N/A	Industrial Sector 108.6 2.86 108,130,193 MMBtu \$21.04 309,182,690 MMBTU \$2,275,Y2Y,3Y3,79 #N/A 1.00 #N/A #

Here we will calculate the electricity costs, scaled up to annual usage, for both technologies. Additionally, the heat pump reduces natural gas usage by transporting heat for process use elsewhere in the system. We can account for this by adding a negative input for natural gas. Note that negative inputs can be used throughout TECHTEST to show avoided emissions.

r														
		Reference	es, Notes,	and Assu	Imptions									
		List key referen	nces and	IHP Calculat	ions: https://ww	ww.energy.go	w/sites/prod/files	/2014/05/f15/	heatpump	.pdf				
			sed to prepare							10401				
			ded in this sheet.	0										
		Add as many re	ows as needed.											
				7. J.										
-		Calculatio	ns											
		Use this section f	for project-speci	fic calculation	s and detailed n	eferences su	pporting the data	above. Add as ma	ny rows as	s needed	1.			
		Commercial B	enchmark Fle	ctricity llsa	te via Evanora	tive Cooli	ng linits							
		Contract of the second second												
		4 fans at 50 hp e	each operator to	cool this wate	er, so to estimate	e electricity	required:							
		100 hp * 4 fans	* 0.7457 kW/h	p * 24 hours	per dayday = 35	79.36 kWh	from grid used to c	ool 2 million gall	ons of was	stewater	each day			
		3579.36 kWh *	3412.14 BTU /	kWh * 1 MM	BTU/1000000 E	BTUs =	12.213	MMBTUs per day	in electric	city cons	sumption for gr	id to cool 2 million	gallons of wast	ewater a day
		100 10 10 100						5 10 WE 10		1.12				
		Waste Heat Rec	overy Unit/Heat	Pump Calcula	tions for Electric	city Usage R	equired and Heatir	ng Captured/Deliv	vered by H	leat Pun	np			
		Source:		https://www	.energy.gov/site	es/prod/files	s/2014/05/f15/h	neatpump.pdf						
				**see page	12									
		and the second second					-							
		Approach Temp:		20		d	F '	**assumed value	based on	DOE SOU	irce above			
		Working Fluid												
		-		80		d	-							
		T _{in} :												
		Tout:		195		d	E	**assume heat ge	enerated v	vould rep	place steam he	at required for steri	lization/hot wa	ater at 175 dF
		Heat Source (i.e.	WWTR stream											
				105		d	-							
		T _{in} :												
		T _{out} :		100		d	F		I					
TECHTEST Landing Page	Full Entry Home Page	Rapid Data Entry Home Page	Project Basics Benchmarks	& Market	Functional Unit	Raw Materials	Manufacturing Energy	Use Phase Energy	СарЕх	ОрЕх	Unit Conversion	Grid Mix Customization	Summary Tables	Results Dashboard

The entered values are determined in the Calculations section at the bottom of this tab.

				 1						Source-to-S	Site				
								Specific :	100-yr	Ratio (Btu					
								GWP (Ib	CO2-eq	primary / B	tu	Annua	al Energy	Consumption	
		Sector 8	k Energy Type	Energy S	Source			/ MMBtu)	onsite)		(1	fuel spec	ific units)	
				0	ranspo	tation Sect	tor								
		Electric	city	Electric					108.6		2.86				
		Petrole	um Look Up					#N	/A		1.00				
		Natura	Gas	Natural	Gas (pipe	lines and fuel)			138.2		1.00				
		Renewa	able Fuels	Biomass					165.3		1.00				
		Custom	Input I												
		Custom	Input II												
		Custom	Input III												1
													Нур	othetical Ann	lal
													Ene	rgy & Emissio	ns:
														or equivalent	dy:
								_							
TECHTEST Landing Page	Full Entry Home Page	Rapid Data Entry Home Page	Project Basics & Benchmarks	Functional Unit	Raw Materials	Manufacturing Energy	Use Enei	Phase rgy	pEx OpEx	Unit Conversion	Grid Mix Customiz		Summary Tables	Results Dashboard	

The transportation sector does not apply to our waste heat recovery scenario, so only energy impacts in the industrial sector are entered.

	Econo	omic C	onsidera	ntions	U.S	. DEPARTME	NT OF ENE	RGY (D	OE) OFFICE OF	FENERGY	EFFICIENC	CY AND	RENEWABLE	E ENERGY (EERE)	
														age Techno		ECHTEST)
	CapEx							it all the			turn to Pla	anning I	Page			
					Ma	anuractur	ing cap		xpenses (Capex)						
	Capture	s the exp	enses for			the second second second second		Berner Services								nercial benchmark (
	•	•	her one-tim	e	The	reference prod	uction quan	tities (as	entered into the	Functional	Unit tab) are	e shown	below for each	technology. If you	need to chang	e these, edit in the F
		•	d to manufa				New Tech	nology	(at Industrial s	Scale)						
	•	•	unctional un		Tecl	hnology Name	Waste Hea	t Recove	ery (Heat Pump)							Technology Na
	The esta	upilstied to	unci jonar un	rı.	Spe	cific Product	Cooled Wa	ste Wate	er							Specific Produ
	Note: t	here cost	are often		Refe	erence Quantity	2.00		Million Gallons	Re .						Reference Qua
			he volume o	c			(quantity)		(units)							
	•			r	For	the new techn	ology indic	ate the a	nnual production	volume for	the industri	al scale f	acility that will	be used to assess	capital expense	es For the comme
	product	t produced	1.						e will also be use						aprial experies	time expenses)
						Annual Facility	/]					Annual Fa
	Data in	puts inclu	de:		Pr	oduction of End			Million Gallon	s	of (end-us	se produ	uct not yet de	fined) per year		Production of use Pro
	Pro	cess equip	oment				(facility pro	duct.)	(units)		1					
	Nor	n-process	equipment		For	both the new to	chnology (k	off) and c	commercial benc	hmark (right) list canits	alevnens	es in the table	s below. Consider :	a facility of the	size and typical prod
		jineering			abo	ve. For each ite	m listed, na	me the e	expense and estir	mate the pu	chase price	e and exp	pected lifetime	(for depreciation p	urposes). For f	inanced equipment
	•	struction			cost	t of financing. U	se the spac	es below	to list references	s, assumptio	ons and cald	culations	. Do not includ	e recoverable "wor	king capital" e	expenses.
		her one-ti	ma aasta		A de	efault value of §	5% of CapEx	annually	is assumed for a	annual equip	oment and f	facility m	aintenance. Th	iis value may be ad	justed if desire	ed.
	UT	ner one-T(me cosis		I											
TEC	CHTEST	Full Entry	Rapid Data Entry	Project Basic	s & Mar	ket Function	al Raw		lanufacturing	Use Phase	COEX	OpEx	Unit	Grid Mix	Summary	Results
	nding Page	Home Page	Home Page	Benchmarks		Unit	al Raw Mate		nergy	Energy	Capex	Opex	Conversion	Customization	Tables	Dashboard

Moving on to the Economic Considerations category, the CapEx (or capital expenses) tab captures the expenses for machinery and other one-time purchases required to manufacture the established functional unit. However, note that these costs are often independent of the volume of product produced. Data inputs here include process and non-process equipment, engineering, construction, and any other one-time costs required to commission the referenced technology.

_														
							e <u>industrial sca</u> assess opera					ess capital ex	penses	
Produc	nual Facility ction of End ise Product	- 7	30	Million G	allons	o	of (end-use pr	oduct no	ot yet de	efined	i) per yea	ar		
		(facility pr	roduct.)	(units)										
time ex	penses). Th	is facility si	Contraction of the second second second		and the second processors		e for the <u>industr</u> erating expens			at will I	be used to	assess capita	I expenses	(i.e., one-
	nual Facilit		30	Million Ga	llons	of (end-use prod	uct not y	et defin	ed) pe	er year			
	use Product	(facility pr		(units)										
		(raciiity pr	oudet.)	(units)										
		id Data Entry ne Page	Project Basics & Benchmarks	Market	Functional Unit	Raw Materials	Manufacturing Energy	Use Phase Energy	CapEx	OpEx	Unit Conversion	Grid Mix Customization	Summary Tables	Results Dashboard

We start by entering the annual facility output of the functional unit (not the reference quantity) for both technologies.

	New	[,] Technolog	y: Heat	Pum	р				Bench	mark: Ev	vaporat	tive		
										Conden.	ser			
New Technology	- Capital Expense	Capital Expense Items (descriptions)	Purchase Price (\$)	Expected Equipment Lifetime (years)	Annual Capital Cost for Facility (\$)	Capital Cost for Functional Unit (\$)	Commerical Be	Examples	gy - Capital Expen		Expected Equipment Lifetime (years)	Annual Capital Cost for Facility (\$)	Scaled Annual Capital Cost (\$) (Adjusted to new tech. facility size)	Capital Cost for Functiona Unit (\$)
Process Equipment	furnaces, reactors	WHR — Heat Pump	\$254,306	10	\$25,431	\$69.67	Process Equipment	furnaces, reactors	Evap. Conden.	ers \$1,000,000	25	\$40,000	\$40,000	\$109.59
Non-process	piping, control systems, power	Piping	\$50,000	ipment Total: 35	\$25,431 \$1,429	\$69.67 \$3.91	Nonprocess	piping, control	Piping	\$50,000	Equipment Total	\$40,000 \$1,429	\$40,000 \$1,429	\$109,59 \$3.91
Equipment	equipment						Equipment	systems, power equipment.				\$1,429	\$1,429	\$3.91
Engineering & Construction	engineering, design, procurement, construction	Design Installation	Non-Process Equ \$10,000 \$127,153	ipment Total: 15 15	\$1,429 \$667 \$8,477	\$3.91 \$1.83 \$23.22	Engineering & Construction	engineering, design, procurement, construction	Design Installation		Equipment Total 25 25	\$¥00 \$20,000	\$400 \$20,000	\$1.10 \$54.79
		E	ngineering & Cons	truction Total:		\$25.05				Engineering & Co	Instruction Total	\$20,400	\$20,400	\$55.89
Other CapEx	land, commissioning, contingency						Other CapEx	land, commissioning, contingency, spare parts.						
	1		Total Ca	r CapEx Total: pital Expense:	\$36,003	\$98.64					ther CapEx Total Capital Expense	\$61,829	\$61,829	\$169.39
	Annual	Capital Equipment/Facility Total Capital I	Maintenance (typic Expense, Including		5% \$37,803	\$98.64		Annual		acility Maintenance (ty pital Expense, <mark>Includi</mark>		5% \$64,920	5% \$6 4,920	\$169.39
					per 730 mil go (Annual Facility Production)	Is per 2 mil ga (Reference	ls				F	per (Annual Facility Production)	per 130 mil gals (Scaled Facility	per 2 mil go (Referen Quantit
ECHTEST anding Page	Full Entry Home Page	Rapid Data Entry Home Page	Project Basics Benchmarks	& Marke	t Function	al Raw Materia	Manufactu Ils Energy	ring Use Pha	ase CapEx C	pEx Unit Conversio	Grid Mi			sults shboard

Next, the costs and associated expected lifetime for the necessary system components are added.

Keep in mind that the level of granularity of the capital expenses for the new technology must be equal to that of the benchmark to ensure a fair cost comparison.

OpEx				U.S. DE	PARTMENT	OF ENERGY	(DOE) OFFICE (OF ENERGY	Y EFFICIE	NCY AND RENEV	VABLE ENERGY	(EERE)		
				Tech	10-econo	mic, En	ergy & Carb	on Heu	ristic	Tool for Earl	y Stage Teo	chnologi	es (TE	CHT
										Return to Pla	nning Page			
Models	the cost	⁺ of opera	nting	Manu	facturing	g Operat	ing Expense	es (OpE	x)					
the tea	challary	required	to	In this ta	b, you will estin	nate operatir	ng expenses (OpEx	- i.e., recurri	ng costs) f	or the new technolo	ogy (left) and for th	e commercial	benchma	irk (righ
	•••	•	10							for convenience (er				
produc	e the est	tablished				-				ider the annual cos		he size indicat	ed in the	CapExt
functio	nal unit.													
•	•			-			New Technolo	gv (at Indu	strial Sc	ale)				
Some i	nputs in	this tab i	nay	Technolo	gy Name		Waste Heat Rec			,			-	Tech
	, applicab		•	Specific Product Cooled Waste Water								Spec		
nor be	applicab	10.		Reference	e Production	Quantity	2.00	Million G	allons					Refe
				Annual F	acility Product	ion Quantity	730.00	Million G	allons					Annu
							(quantity)	(units)						
				Direc	t Labor C	osts								
				and the second s						ering a facility of the				
										cost instead, data i				
						-		-						
				If labor c	osts are unkno	own, rules-of-t	humb based estin	ation metho		2% (considered a t e used. See the tab				
				Calculat	ion Tool: Lab	or Cost Estin	mation Rules-of-	Thumb						
									_					,
CHTEST	Full Entry	Rapid Data Entry	Project Basics &	Market	Functional	Raw	Manufacturing	Use Phase	CapEx	CoEx Unit	Grid Mix	Summary	Results	

The OpEx (or operating expenses) tab models the cost of operating the technology required to produce the established functional unit. Depending on your project scope, some inputs in this tab may not be applicable.

	neoloyees and annual pay rates. If date the section. The default percentage for fr		colle balow en											1
	ection. The default percentage for fr	ata are available as												
								default formulas. Do not	t include administrative	e labor in this				
we training an grant of the strength of the strengt of the strength of the strength of the stre								nis section).						
Number of T Average miniposes Finge Burstle & General (for ficially of large general state) Cost (for ficialty of large general state) Cost (for ficial	alculation Tool: Labor Cost Estim	nation Rules-of-Th	umb											
Number of T Average miniposes Finge Burstle & General (for ficially of large general state) Cost (for ficialty of large general state) Cost (for ficial	law Technology - Direct Labor Costs						Commercial Bonchmark - Direct Laboration	a Coste						
Number of FTE Number of FTE<	ew rechnology - Direct Labor Costs						Commercial Benchmark - Direct Labo	ir Costs						
Employee Rate Outlended Rate (%) Solution Rate (%)		Number of FTE						Number of FTE						
uppervisions 0.0046 \$15,000 720 \$1,020 \$2,020 \$2,020 \$2,020 \$2,021 \$1,020 \$2,020 <td></td> <td>Employees</td> <td></td>		Employees												
Providence of the second	Direct Labor (equipment operators & upervisors)	0.0096	\$75,000	72%	\$1,240	\$3.40		0.0332	\$75,000	72%	\$4,279	\$4,279	\$11.72	
Providence of the second			Total Ope	erating Labor Cost:	\$1,240	\$3.40		•	Total Operating	ng Labor Cost:	\$4,279	\$4,279	\$11.72	
Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference quartify production Channal recting inference production Channal recting inference production <td></td> <td></td> <td></td> <td></td> <td>per</td> <td>per</td> <td></td> <td></td> <td></td> <td></td> <td>per</td> <td>10.00 million 10.00 million 10.00 million</td> <td>per</td> <td></td>					per	per					per	10.00 million 10.00 million 10.00 million	per	
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the optimicant section, enter any type ignificant recurring costs (not tisted in the Lakor. Materials), or many categories aboves in the table beck. Etimate data on an annual basis, considering a facility of the size indicated earlier. Credits (e.g., refunds from costs in the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the size indicated earlier. Credits (e.g., refunds from costs of the earlier. Credits (e.g.,					Production)						Production)			
The name and the second approducts or spent materials) may also be provided in this table are negative values, if appicative or on Overhead: most indirect costs and as supplies, property tax, and R&D are now excluded by default in TECHTST. Accurate estimation of indirect costs for early stage technologies can be challenging, and it would be invisible for indirect costs themes the how technology and commercial these costs gravity does not significantly does not significant the accurate settimates or costs are addressed elsewhere in TECHTST. Increasing the costs for early stage technologies can be challenging, and it would be invisible for instructions the technologies. However, if data are available, indirect costs may be included in this table for more provided in this table for instructions are addressed elsewhere in TECHTST. Increasing the costs for early stage technologies can be challenging, and it would be unusual for these costs to drive addressed elsewhere in TECHTST. Increasing the cost of the available, indirect costs may be included in this table for more provided in this table for instructions are addressed elsewhere in TECHTST. Increasing (increasing to the cost of the available), indirect costs may be included in this table for instructions are addressed elsewhere in TECHTST. Increasing the cost of the available, indirect costs may be included in this table for instructions are addressed elsewhere in TECHTST. Increasing the cost of the available, indirect costs may be included in this table for instructions are available. Increasing the cost of the cost of the availabl		7												7
bit con Overhead: most infinite costs such as supples, property tax, and R&D are now excluded by default in TECHTEST. Accurate estimation of indirect costs for early-stage technologies can be challenging, and it would be unusual for these costs to date are variable, indirect costs may be included in this table for impleteness. General overhead, employee fringe benefits, and facility/equipment maintenance costs are addressed elsewhere in TECHTEST (in the Labor and CapEc sections) and should not be duplicated here. were fechnologie - Other Recurring Costs maintenance costs are addressed elsewhere in TECHTEST (in the Labor and CapEc sections) and should not be duplicated here. searing Cost (description) Annual Recurring (cost (s) granting (cost (s) granting) (per reference) elsewhere (granting) (per reference) elsewhere (granting) (per reference) elsewhere for cooling water supplied to condenses: \$22,000								asis, considering a tacili	ty of the size indicated	earlier. Credits	(e.g., refunds from			
the change of the section of the se	X IDCentrative mining includes notin s	ale of secondary pro	ducts of spent	materiais) may also	be provided in this o	ible as negative value	s, if applicable.							
exerring Cost (description) Lubrication 5, 2000 \$15,700 Lubrication 5, 2000 Lubrication 6, 2000 Lubricatio														
ev Technolog- Other Recurring Costs ex Technolog- Other Recurring Costs Annual Recurring Cost (s) Commercial Benchmark- Other Recurring Costs Scaled Annual Recurring Cost (s) Cost (s										be included in th	his table for			
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Recurring Cost (description) Recurring Cost (s) (per reference cost (s) Recurring Cost (description) Annual Recurring (per reference cost (s) Recurring Cost (description) Lubrication & Mointenance Services \$5,000 \$13,70 Vater treatment management for cooling water supplied to condensers \$12,000 \$12,000 \$23,28 Image: Cost (s) (per reference cost (s)														
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Lubrication & Maintenance Services \$5,000 \$13,70 Water treatment management for cooling water supplied to condensers \$12,000 \$32.88				1		(per reference						(adjusted to new	(per reference	
		•							4 6 7 4					l l
Total Other Recurring Cost: \$5,000 \$13,70 Total Other Recurring Cost: \$5,000 \$13,70	Lubrication & Maintenance	Serv/ces			\$5,000	\$13.70	Water treatment managen	ent for cooling w	afer supplied to a	condensers	\$12,000	\$12,000	\$32.88	
Total Other Recurring Cost: \$5,000 \$13,70 Total Other Recurring Cost: \$17,000 \$17,000 \$17,000 \$13,70					-									
Total Other Recurring Cost: \$5,000 \$13,70 Total Other Recurring Cost: \$17,000 \$17,000 \$17,000 \$13,78					1									
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Total Other Recurring Cost: \$5,000 \$13,70 Total Other Recurring Cost: \$12,000 \$12,000 \$33,88														
			Total Oth	er Recurring Cost:	\$5,000	\$13.70			Total Other Re	ecurring Cost:	\$12,000	\$12,000	\$32.88	
per						per					per	575	5 STO	
T20 Million Galless 2 Million														
Production) Production, New Tech												Production, New Tech		
Equivalent)												Equivalent	9	
	EST Full Entry	Rapid Data	Entry F	Project Basics &	& Market	Functional	Raw Manufacturing	Use Phase	e CapEx Op	pEx Unit	Grid	l Mix	Summary	Results
EST Full Entry Rapid Data Entry Project Basics & Market Functional Raw Manufacturing Use Phase CapEx OpEx Unit Grid Mix Summary Results	ng Page Home Page	Home Page	F	Benchmarks		Unit	Materials Energy	Energy		Conv	version Cust	tomization	Tables	Dashboard

Data inputs include the direct labor costs, along with any other recurring costs required to operate or create the technology.

In our example, there are more system aspects to manage with the benchmark technology, so the number of full-time employees will be higher.

New Technology - Raw Material In	outs					Commercial Benchmark - Raw Mate	rial Innuts					
New Technology - Raw Material In	Amount of Material (to produce		Specific Cost	Annual Materials	Materials Cost (\$)	Commercial Benchmark - Raw Mate	Amount of Material		Specific Cost	Annual Materials	Scaled Annual Materials Cost (\$)	Materials Cost (\$
Material Inputs (list)	reference quantity)	unit	(\$/unit) (for this material)	Cost (\$) (per year)	(per reference guantity)	Material Inputs (list)	(to produce reference guantity)	unit	(\$/unit) (for this material)	Cost (\$) (per year)	(adjusted to new tech, facility size)	(per reference guantity)
ubrication (to run Fans)	2.34	kg	\$6.00			City water supply to evaporative condensers	17010.30928	gallons	\$0.002	\$12,417.53	\$12,418	\$34.0
Copper	0.367303562 kg \$0 0.00 loop for micro mitigation loop for micro mitiga		3.322326031	gallons	\$19.09	\$23,150.57	\$23,151	\$63.4				
Elastomer	0.160569863	kg	-	\$0	\$0.00	Steel low Alloy	0.317497841	kg	-	\$0.00	\$0	\$0.0
HDPE	0.005017808	kg		\$0		Stainless Steel	0.349464668	kg		\$0.00		\$0.0
Low alloyed steel	0.321139726	kg		\$0		Aluminium	0.398757315	kg	-	\$0.00	\$0	\$0.0
Lubricating Oil (Manufacturing)	0.027096164	kg		\$0		Bricks	0.346265477	Bricks	1	\$0.00	\$0	\$0.0
PVC	0.016056986	kg		\$0		Methacivlate	0.288178188	kg	-	\$0.00	\$0	\$0.0
Reinforced Steel	1.304630137	kg	+	\$0		Polyurethane	0.025744085	kg	-	\$0.00		\$0.0
Kelmorceu Steer	1.304030137	ng	-		\$0.00	PVC	0.495184723	kg	-	\$0.00	\$0	\$0.0
			otal Materials Cost:	\$5,125	\$14.04	1.0	0.400104125		Total Materials Cost:	\$35,568	\$35,568	\$97.
				Production	(Reference	Will auto- _F				Production	Production New	Quant
Fnergy Costs				Production						Production)	Production, New Tech Equivalent)	Quanti
		b are reprinted	d here for convenienc) Quantity)	s in the Manufacturing Energy tab.				Production)		Quanti
Energy costs entered into the "Mai New Technology - Energy Cost Dat	a Onsite Energy Consumption (MMBtu) (to produce reference		Annual Energy Cost	e. If data need to be Energy Cost (\$) (per reference) Quantity)	s in the Manufacturing Energy tab.	st Data Onsite Energy Consumption (MMBtu) (to produce reference		Annual Energy Cost	Scaled Annual Energy Cost (\$) (adjusted to new	Tech Equivalent)	Quant
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source	a Onsite Energy Consumption (MMBtu) (to produce reference quantity)	unit	Annual Energy Cost (\$)	e. If data need to be Energy Cost (\$) (per reference quantity)) Quantity)	s in the Manufacturing Energy tab. Commercial Benchmark - Energy Cos Energy Source	st Data Onsite Energy Consumption (MMBRu) (to produce reference quantity)	unit	(\$)	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size)	Tech Equivalent) Energy Cost (\$) (per reference quantity)	Quanti
Energy costs entered into the "Ma New Technology - Energy Cost Dat Energy Source Electricity	a Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.00	unit MMBtu	Annual Energy Cost	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10) Quantity)	s in the Manufacturing Energy tab. Commercial Benchmark - Energy Cor Energy Source Electricity	st Data Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.37	MMBtu		Scaled Annual Energy Cost (\$) (adjusted to new	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81	Quant
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity	a Onsite Energy Consumption (MMBtu) (to produce reference quantity)	unit	Annual Energy Cost (\$)	e. If data need to be Energy Cost (\$) (per reference quantity)) Quantity)	s in the Manufacturing Energy tab. Commercial Benchmark - Energy Cos Energy Source	st Data Onsite Energy Consumption (MMBRu) (to produce reference quantity)		(\$)	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size)	Tech Equivalent) Energy Cost (\$) (per reference quantity)	Quant
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity	a Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.00	unit MMBtu	Annual Energy Cost (\$)	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10) Quantity)	s in the Manufacturing Energy tab. Commercial Benchmark - Energy Cor Energy Source Electricity	st Data Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.37	MMBtu	(\$)	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size)	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81	Quanti
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity Petroleum Coal	a Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.00 0.01	unit MMBtu MMBtu	Annual Energy Cost (\$)	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10 \$0.00 \$0.00) Quantity)	s in the Manufacturing Energy tab. Commercial Benchmark - Energy Cos Energy Source Electricity Petroleum	onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.37 0.01	MMBtu MMBtu	(\$)	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size) \$2,851.15	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81 \$0.00	Quanti
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity Petroleum Goal Natural Gas	a Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.00 0.01 0.01	unit MMBtu MMBtu MMBtu	Annual Energy Cost (\$) \$37	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10 \$0.00 \$0.00) Quantity)	s in the Manufacturing Energy tab. Commercial Benchmark - Energy Cos Energy Source Electricity Petrolosum Coal	Onsite Energy Consumption (MMBRU) (to produce reference quantity) 0.03 0.01 0.01 0.01	MMBtu MMBtu MMBtu MMBtu	(\$) \$2,851	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size) \$2,851.15	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81 \$0.00 \$0.00 \$0.00	Quant
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity Petroleum Coal Natural Gas Renevable Sources	a Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.00 0.01 0.01 0.01 0.01 0.00	unit MMBtu MMBtu MMBtu MMBtu MMBtu	Annual Energy Cost (\$) \$37	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10 \$0.00 \$0.00 \$0.08 \$0.08) Quantity)	Commercial Benchmark - Energy tab.	st Data Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.01 0.01 0.01 0.00	MMBtu MMBtu MMBtu MMBtu MMBtu	(\$) \$2,851	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size) \$2,851.15	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81 \$0.00 \$0.00 \$0.08 \$0.00	Quant
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity Petroleum Coal Natural Gas Renewable Sources Steam	a Onsite Energy Consumption (MMBtu) (to produce quantity) 0.00 0.01 0.01 0.01 0.01 0.00 0.	unit MMBtu MMBtu MMBtu MMBtu MMBtu	Annual Energy Cost (\$) \$37	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00) Quantity)	Commercial Benchmark - Energy Cos Energy Source Electricity Petroleum Coal Netural Gas Renewable Sources Steam	Onsite Energy Consumption (MMBtu) (to produce reference quantity) 0.01 0.01 0.01 0.00	MMBtu MMBtu MMBtu MMBtu MMBtu MMBtu	(\$) \$2,851	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size) \$2,851.15	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Quant
nergy costs entered into the "Mai lew Technology - Energy Cost Dat nergy Source lectricity etroleum coal latural Gas tenewable Sources Team	a Onsite Energy Consumption (MMBU) (to produce reference quantity) 0.00 0.01 0.01 0.01 0.00	unit MMBtu MMBtu MMBtu MMBtu MMBtu MMBtu	Annual Energy Cost (\$) \$37 \$28	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.10 \$0.00 \$0.00 \$0.08 \$0.00 \$0.00 \$0.00 \$0.00) Quarrity) adjusted, make change	Commercial Benchmark - Energy tab.	Consite Energy Consumption (MMBBi) (to produce reference quantity) 0.33 0.00 0.00 0.000 0.000 0.000	MMBtu MMBtu MMBtu MMBtu MMBtu MMBtu MMBtu	(\$) \$2,851 \$28	Scaled Annual Energy Cost (\$) (adjusted to may tech. facility size) \$2,851.15 \$28.23	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00	Quan
Energy costs entered into the "Mai New Technology - Energy Cost Dat Energy Source Electricity Petroleum	a Onsite Energy Consumption (MMBU) (to produce reference quantity) 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.0000 0.00000 0.0000 0.00000 0.00000 0.0000 0.0000 0.00000 0.00000 0.0000000 0	unit MMBtu MMBtu MMBtu MMBtu MMBtu	Annual Energy Cost (\$) \$37 \$28 \$65 \$65 \$730 Millon Gallons	e. If data need to be Energy Cost (\$) (per reference quantity) \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.01 Beterence Quantity) Quantity) adjusted, make change	Commercial Benchmark - Energy Cos Energy Source Electricity Petroleum Coal Netural Gas Renewable Sources Steam	Consite Energy Consumption (MMBBi) (to produce reference quantity) 0.33 0.00 0.00 0.000 0.000 0.000	MMBtu MMBtu MMBtu MMBtu MMBtu MMBtu	(\$) \$2,851	Scaled Annual Energy Cost (\$) (adjusted to new tech. facility size) \$2,851.15 \$28,23 \$2,879.38 \$2,879.38 \$2,879.38 per 730 Milion Gallona (Scaled Facily)	Tech Equivalent) Energy Cost (\$) (per reference quantity) \$7.81 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$0.00 \$7.89 per 2Milion Galons (Reference Quantity)	Quan

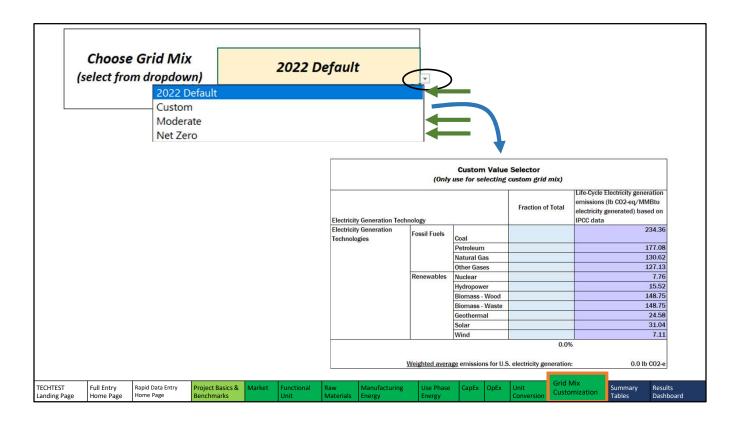
Costs that we entered earlier on the raw materials and manufacturing energy tabs will auto-populate the lower tables to give a full cradle-to-gate picture. And note that these data inputs are to be entered based on a facility's annual production basis.

			Ор	Ex S	Summar	У								
	New Technology - OpEx Sur		η			Bencl		:: Evapora denser	tive					
	Waste Heat Recovery (Commercial Benchmark - OpEx Summary										
	waste neat necovery (Heat Pump)		Evaporative Condenser										
	OpEx Category	Annual Recurring Cost (\$)	Recurring Cost (\$) (per reference quantity)			100.000		Annual Recurring	(adjusted to new	Recurring Cost (\$ (per reference)			
	Direct Labor Cost	\$1,24	0 \$3.40				Cost (\$)	tech. facility size)	quantity)	70				
	Raw Materials Cost	\$5,12	5 \$14.04		Direct Labo			\$4,279	\$4,279	\$11.7	-			
	Energy Cost	\$6	5 \$0.18		Raw Materi		1	\$35,568	\$35,568	\$97.4	-			
	Other Recurring Costs	\$5,00	\$13.70		Energy Cos			\$2,879	\$2,879	\$7.8	-			
	Total Operating E)	Other Recu	otal Operating	Expense-	\$14,738	\$14,738 \$57,464	\$40.3 \$157.4				
		pi 730 Million Gallor (Annual Facili Production	2 Million Gallons ty (Reference Quantity)					per 730 Million Gallons (Annual Facility	per 730 Million Gallons	pe 2 Million Gallor (Reference Quantit	er IS			
HTEST	Full Entry Rapid Data Entry	Project Basics & Mark	ket Functional	Raw	Manufacturing	Use Phase	СарЕх	OpEx Unit	Grid Mix	Summary	Results			

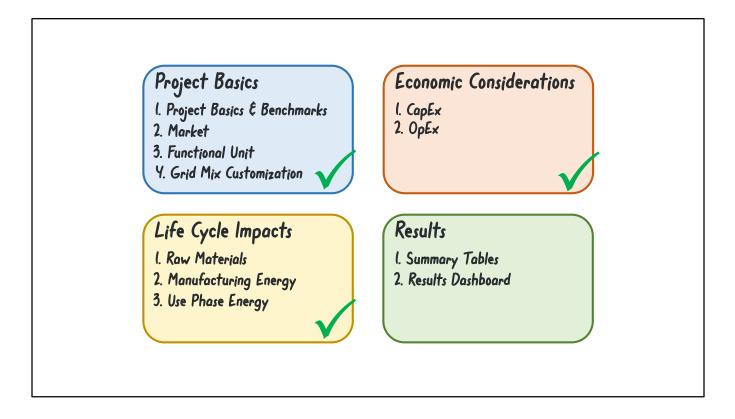
We can now see a full summary of the operating expenses for the two technologies in the OpEx Summary section, with a significant improvement anticipated for the new heat pump technology.

Proie	ect Bas	i ics omization				F ENERGY (DOE)						Y (EERE) echnologies (TECHTES	T)	
								1				eturn to Planning Page	~/	
Grid N	Mix Custi	mization		Grid M	lix Custo	mization								
Allows	customi	zation of							. The 2022 cu	urrent US		ions in the TECHTEST tool. The sp default. A Moderate and Net Zer ppdown menu.		
electri	icity aria	l mix base	d on											
		technolo			e Grid Mix om dropdown,	202	2 Default							
usea.				Electricity	Generation Tee	chnology					Fraction of Total	Life-Cycle Electricity generation emissions (Ib CO2-eq/MMBtu electricity generated) based on IPC data		02-eq/MMBtu data
					Generation	Fossil Fuels		1			21.9%			234.36
				Technolog	ies	FOSSII FUEIS	ſ	Coal		ר–	0.50	4.77		177.00
								Petroleu Natural			0.5%		1.11	177.08
								Other Ga		-++	0.3%		2 A A	127.13
						Renewables		Nuclear			18.9%	7.	76	7.76
							ſ	Hydropo	wer		6.3%			15.52
								Biomass			0.9%		14 M 1	148.75
							- 1	Biomass	S		0.5%		2 T	148.75 24.58
								Solar	na	-++	2.8%			31.04
							L	Wind			9.2%	7.	11	7.11
											100.0%			
							Weigh	ted average	emissions fo	or U.S. ele	ctricity generation	108.6 lb C0	z-e	
							Return to Hon	ne Page						
TECHTEST Landing Page	Full Entry Home Page	Rapid Data Entry Home Page	Project Basics & Benchmarks	Market	Functiona Unit	l Raw Materials	Manufacturi Energy		Jse Phase Energy	CapEx			ummary ables	Results Dashboard

One final tab before heading into our results is the Grid Mix Customization tab, which allows customization of the electricity grid mix based on the generation technologies used, including fossil fuels and renewable sources.



The Choose Grid Mix dropdown menu allows you to choose between three preset scenarios: a 2022 U.S. Default scenario, a hypothetical Moderate scenario (on the way to Net Zero), and a Net Zero scenario that consists almost entirely of renewables. There is also a Custom option, which can be used to manually edit the mix of energy generation technologies and emissions.



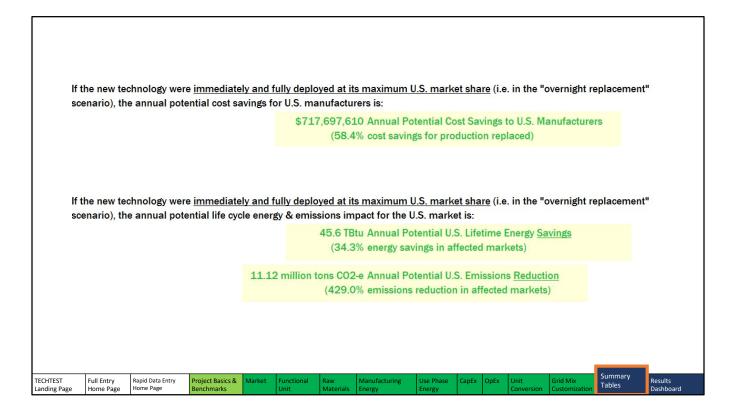
Once all the previous sections have been completed, the results from our TECHTEST analysis can be viewed in table and graph form.

Results			Y (DOE) OFFICE (
Summary Tables		onomic, En Immary Tal		on Heuri	SLIC TO	of for	Early	stage rechi	noiogi	es (TECHTEST)	
				is tab. After en	itering data	into the d	lata input	tabs, results will a	ppear in th	ne green cells of the summ	
Shows detailed costs,	Project Basics	Project Title			Waste Hea	t Recover	v Cooling	in Beverage Manu	facturing		
Siluws defulled costs,		Lead Organizati	on		Hypothetic				U		
and a sure and employed		Collaborative P	artner(s)		Staff						
energy use, and emission		Principal Invest	igator		John Doe,	Hypotenti	cal Nation	nal Laboratory			
		AMO Technolog	AMO Technology Manager								
of each aspect of the		Project Timeline	January 2023 to January 2025								
•		Funding Mecha	R&D Proje	ct							
manufacturing and use					_						
manaracturing and use	End-Use Marke	et Market End-Use	Cooled Wa	ste Water	r)						
		Current Annual	US Production		7,300,000)		Million Gallons			
processes.		U.S. Production Technology	that Could be Repla	ced by New	7,300,000	þ		Million Gallons		(assuming replacement of	
		U.S. Potential P	roduction using Nev	Technology	7,300,000)		Million Gallons	18	(based on substitution ratio	
	Benchmarking			Ċ	Technolo	gy Definit	tion(s)	Product or Appli	cation	Current Technology Status	
			New Technology (developed in this project)				ry (Heat	Cooled Waste Water		Typical Technology	
		Commercial I (used in compa	Benchmark		Pump) Evaporative Condenser			Cooled Waste Water		Typical Technology	
		Other Compe	Other Competing Technologies								
									Sunm	TY a ti	
ECHTEST Full Entry Rapid Data Entry Project Basic Benchmarks	& Market Function	nal Raw Materials	Manufacturing Energy	Use Phase Energy	CapEx		Unit Conversia	Grid Mix Customization	Tables	Results Dashboard	

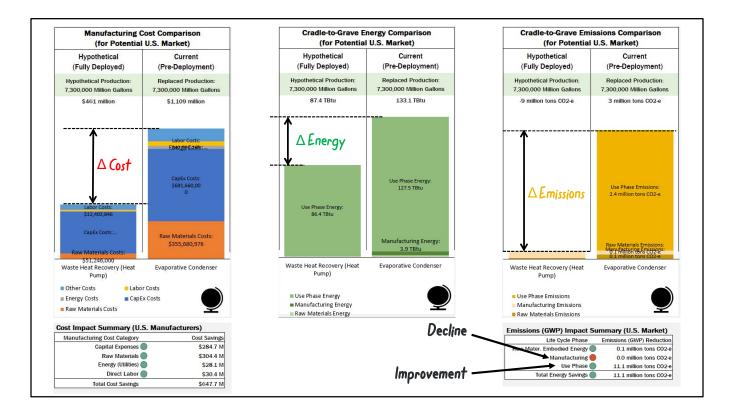
The Summary Tables tab shows the detailed costs, energy use, and emissions of each aspect of the manufacturing and use processes.

			No. of Concession, Name										
		Manufactu	ring Cost R	esults									
		Manufacturing Based on Equivale				New Technolo]			
							Industrial Scale Waste Heat Recovery (Heat		Benchmark	-			
					Technology Na		covery (Hea	Evaporative	Condonsor				
						tity 2 Million Gallo	ne	2 Million Gall		-			
					nererence qua	of Cooled Wa		of Cooled W					
								Functional Unit					
			Process Equipm	nent			\$69.6		\$109.5	9			
			Non-process Eq				\$3.9	1	\$3.9	1			
		Capital Expenses (CapEx)	Engineering & C	Construction	E		\$25.0	5	\$55.8	9			
		(Gapex)	Other Capital Ex										
			Facility & Equips	ment Mainte	enance		\$4.9	3	\$8.4	7			
			Raw Materials			\$14.0	4	\$97.4	5				
		Operating Energy					\$0.1	.8 \$7.89		9			
		Expenses (OpEx)					\$3.4			2			
			Other Recurring	Costs			\$13.7			8			
		Total	CapEx Subtotal	tal			\$108.7						
		Manufacturing	OpEx Subtotal				\$31.3		\$149.9				
		Cost	Total Cost (C	apEx + OpE	Ex)	L.	\$140.0	6	\$336.6	9			
	Life Cycle Compa								-				
	Based on Overall Pot (Cradle to Grave)	iential 0.5. Market		Weste H	New T eat Recovery	echnology	nology Commercial Ber						
	(Cradie to Grave)		Technology Nan		and the second			Evaporative Co	ondoncor				
					00 Million Gallons	8			llion Gallons				
			readenon guant		d Waste Water			of Cooled Wa					
				Energy		Emissions (100-	GWP)	Energy		Emissions (100	-vr GWP)		
	Cradle-to-Gate Energ	X** Raw Materia	als	C.I.SIBJ	0.9 TBtt		tons CO2-e	2110101	1.7 TBtu	0.1 million			
		Manufacturi			0.1 TBt	-	tons CO2-e		3.9 TBtu	0.1 million			
	Gate-to-Grave * * *	Use Phase			86.4 TBt		tons CO2-e		127.5 TBtu	2.4 million			
	Total Energy	Cradle-to-Ga	ite Subtotal		1.0 TBt		tons CO2-e		5.6 TBtu	0.2 million			
	0,	Gate-to-Grav			86,4 TBt	-	tons CO2-e		127.5 TBtu	2.4 million			
			(Cradle-to-Grave)	87.4 TBt		tons CO2-e		133.1 TBtu	2.6 million			
	** Cradle-to-gate en				A CONTRACTOR OF A CONTRACTOR O			r current).					
	** Gate-to-grave ene												
ECHTEST Full Entry anding Page Home Pag		roject Basics & I enchmarks	Market Fun Uni	ctional t		Manufacturing nergy	Use Pr Energy		x OpEx	Unit Conversion	Grid Mix Customizatio	Summar Tables	y Results Dashboard

This tab is great for examining how the contributions from each section contribute to the overall picture, and for directly comparing lifecycle steps.



Looking at the results presented in bolded green text, we can see that our proposed technology offers the potential for significant cost savings, energy savings, and emissions reduction.



The Results Dashboard tab presents the big-picture results of our TECHTEST analysis in graphical form, displaying charts of cost, energy, and emissions for both the reference volume and the overall U.S. market. Results are broken down by contribution, and improvements and declines can be seen as green and red circles, respectively, in the lower tables.



In our example, we can see a consistent improvement with the new technology. The only area in which the heat pump underperforms is the manufacturing phase, where released refrigerants weaken its performance. Luckily, the manufacturing phase is a tiny contribution to the whole picture, and the heat pump ends up being a much better performer in the long run.

Thanks for watching!

In this video, we explored the TECHTEST tool and its capabilities for analyzing the energy, emissions, and cost-saving opportunities of earlystage technologies.

Please check out our other videos in this series to learn more tools and techniques for evaluating costs and environmental impacts of early-stage technologies.

energetics

ENERGY Energy Efficiency & Renewable Energy

In this video, we explored the TECHTEST tool and its capabilities for analyzing the energy, emissions, and cost-saving opportunities of early-stage technologies. This tool was designed to offer a flexible degree of granularity when comparing new and benchmark technologies, while providing clear, detailed results about the opportunities presented by these new approaches.

We hope you've found this video helpful in orienting yourself with the TECHTEST tool. Check out our other videos in this series to learn more tools and techniques for evaluating costs and environmental impacts of early-stage technologies. Thanks for watching!