

# JUMP START GUIDE

Estimating Electrolyzers Using Equipment Model Libraries in Aspen Capital Cost Estimator™ (ACCE)



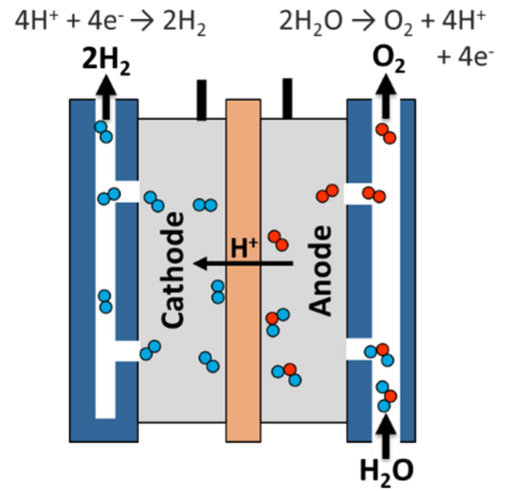
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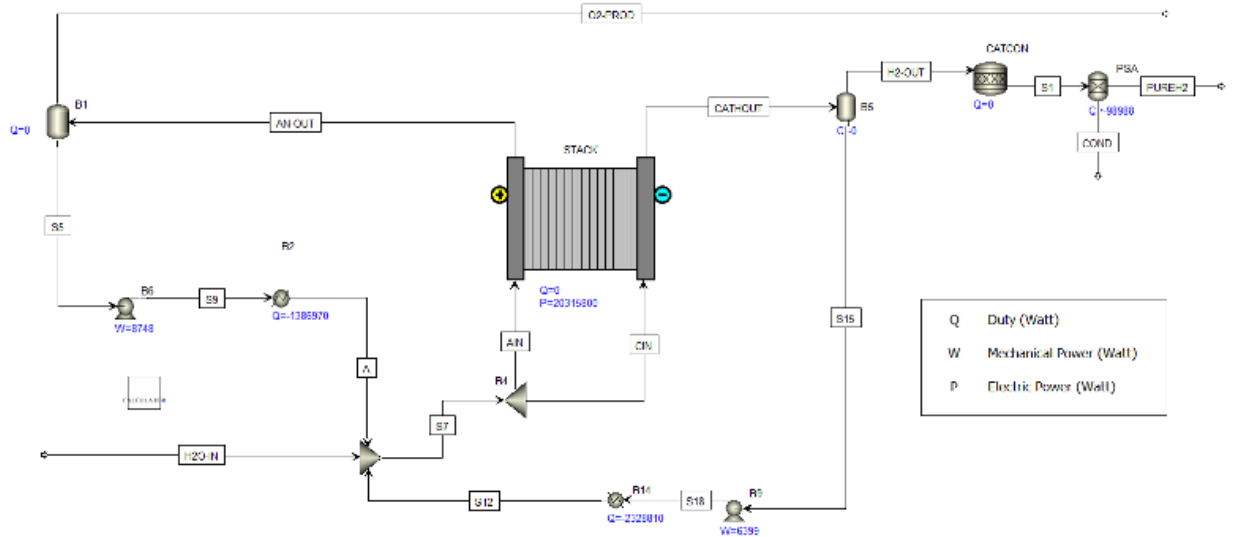
# Hydrogen Production Process

As the world races toward sustainable energy solutions, more and more capital projects revolve around green processes and technology. Such is the case with hydrogen, where electrolysis plays a central role in the quest to reach sustainability goals.

Electrolysis is the chemical process of splitting water molecules into hydrogen and oxygen using a direct current of electricity. To achieve this separation, a device called an electrolyzer is used. This device contains electrodes that attract ions of opposite charge, so the positively charged ions (hydrogen) move toward the negative cathode, and the negatively charged ions (oxygen) move toward the positive anode. In this process, electrons are effectively introduced at the cathode as a reactant and removed at the anode as a product.



Hydrogen Production: Electrolysis | Department of Energy (<https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis>)



## Estimating Electrolyzers

There are different types of industrial-scale electrolyzers, varying by size and function. They can be built using many different, often patented, technologies and are built to operate at different power capacities. Electrolyzers often require additional pieces of equipment, such as pumps, power electronics, a gas separator and other auxiliary components like storage tanks.



Source: [www.fuelcellenergy.com](http://www.fuelcellenergy.com)

Given all these possible variations, when estimating these units, it's very important to keep consistency in their pricing data, deciding to either estimate the full system as a single unit, or separating the main electrolyzer unit from the rest of the other required equipment pieces, and maintaining this convention for all estimated electrolyzer units.

## Estimating Electrolyzer Units in ACCE

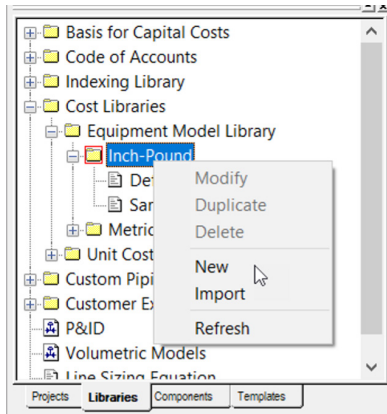
As mentioned, there are a number of possibilities and variables to consider when trying to define the specifications of an electrolyzer. Aspen Capital Cost Estimator (ACCE) enables users to enter their own custom pricing data to estimate specialized equipment not currently available in its default cost library. One of these methodologies involves the creation of an Equipment Model Library (EML), which allows users to store pricing, labor and weight data corresponding to the different types and capacities of electrolyzers that could be required for your projects. EMLs provide a fast and easy way to enter user data into ACCE and enable you to reuse this data as many times as needed in multiple projects.

### Overview

Using this guide, you will create an Equipment Model Library (EML) in ACCE to store cost, labor and weight data corresponding to a Proton Exchange Membrane (PEM) Electrolyzer. This process can be repeated to add data for any type of equipment in ACCE. You will follow best practices for consistent library data, entering equipment quotes that have been normalized to include the same elements for all capacities of the PEM Electrolyzer.

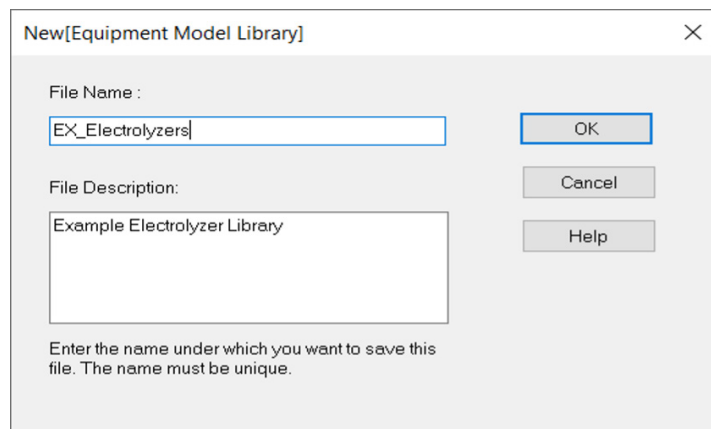
## Task 1 - Create an Equipment Model Library

1. Open Aspen Capital Cost Estimator. If there is any project currently open, make sure to save your file and close it by clicking **File | Close**.
2. Locate the **Palette** on the right-hand side of the window and select the **Libraries** tab.
3. Expand the **Cost Libraries** folder to reveal the **Equipment Model Library** folder.
4. Expand the **Equipment Model Library** folder and right-click on the folder with the **units of measure** appropriate for your projects, then click **New**.



Note: An EML created in Inch-Pound units will only be available for use in a project that uses this same unit set and will not be available in projects using metric units.

5. Enter *EX\_Electrolyzers* as the library name and provide *Example Electrolyzer Library* as the description. Click **OK** when done.



6. Enter today's date as the **base date**. Leave the default **currency base** and click **OK**. Note that a new EML is available in the **Library** tab of the Palette.
7. Click the **Add** button in the **Library** window to begin adding the data for PEM Electrolyzers.

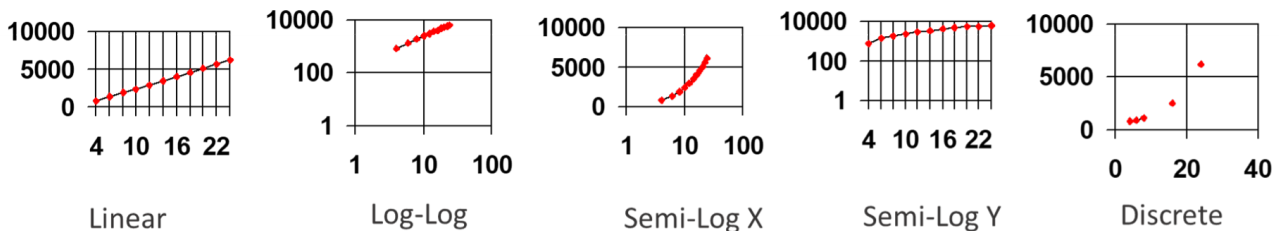
8. Type *PEM1* as the Reference ID of the new item and click **OK**. Next, a form will pop up allowing you to enter all data corresponding to the PEM Electrolyzer. All cells with the red border above the DATA TABLE section must be filled.
9. Enter the following information.

Develop Equipment Library Model

OK Cancel

Name	Units	Item 1
Remarks 1		
Remarks 2		
Item description		PEM Electrolyzer
Currency unit for matl cost		
Source of quote		
Installation option		
Equipment class		SE
Equipment type		ELECTROLY
Material		SS
Code of account		103
Sizing method		LINEAR
Primary sizing parameter		CAPACITY
Primary size unit of measure		
Descriptive parameter A		
Unit of measure A		
Descriptive parameter B		
Unit of measure B		
Equipment setting option		
<b>DATA TABLE</b>		
Size value 1		

EMLs provide five different **sizing methods**, depending on the tendency followed between the equipment capacity and its corresponding material cost.



The first four sizing methods allow you to perform interpolation and calculate costs of any equipment capacity between the smallest and largest capacity values. The last option, Discrete, does not let users do any interpolation and will only allow users to select the entered capacity values in the estimate.

10. Set **KVA** if working in IP units or **MEGAW** if working in Metric units in the **Primary size unit of measure** cell.

11. Enter PWRDRVR in **Descriptive Parameter A** and select **HP** if working in IP units or **KW** if working in Metric units in the **Unit of measure A** cell.

Item description		PEM Electrolyzer
Currency unit for matl cost		
Source of quote		
Installation option		
Equipment class		SE
Equipment type		ELECTROLY
Material		SS
Code of account		103
Sizing method		LINEAR
Primary sizing parameter		CAPACITY
Primary size unit of measure		KVA
Descriptive parameter A		PWRDRVR
Unit of measure A		HP

12. Use the data in the following table to complete the data entry. Use the next screenshot as reference to enter the data.

Develop Equipment Library Model		
OK Cancel		
Name	Units	Item 1
DATA TABLE		
Size value 1		1,000
Cost at size value 1	USD	1,500,000
Setting labor at size value 1		180
Weight at size value 1	LBS	20,000
Size value 2		
Cost at size value 2	USD	

**Disclaimer:** Please note that the following data is for illustration purposes only and does not correspond to any real equipment.

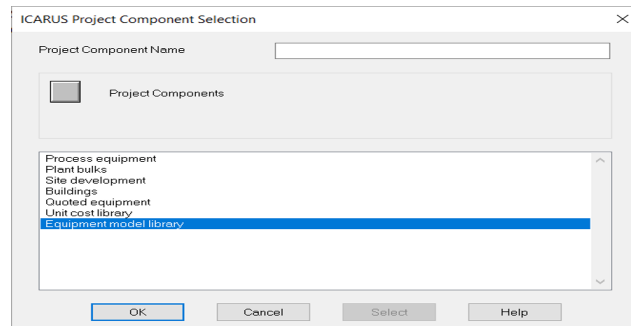
DATA TABLE ENTRY		Data Value	(1)	(2)	(3)
X	SIZE VALUE	Capacity, KVA [MEGAW]	1,000 [1]	5000 [5]	10,000 [10]
Y	COST VALUE	Cost, USD	1,500,000	6,000,000	14,000,000
Y	SETTING VALUE	Setting, Man-Hours	180	400	700
Y	WEIGHT VALUE	Weight, LBS [KG]	20,000 [9,100]	40,000 [18,200]	70,000 [32,000]

13. Click **OK** when finished and then close the Library window.

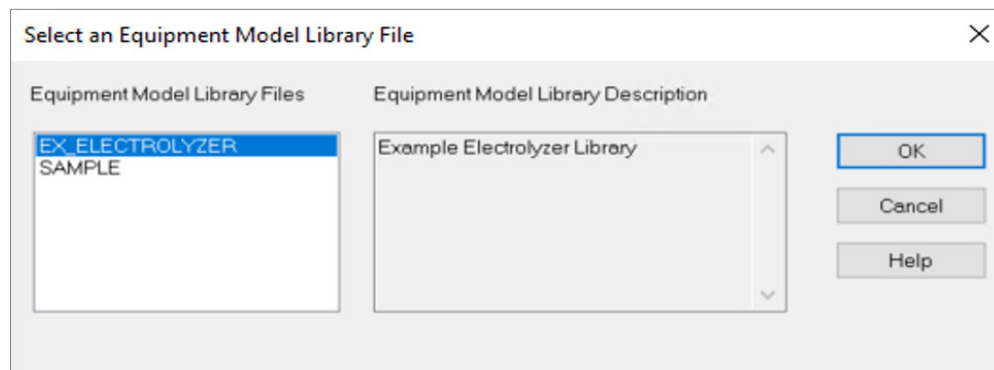


## Task 2 - Add an Electrolyzer Unit to an ACCE Project

14. Open the example scenario Expansion P6 clicking **File | Open**. Go to the **Project View** tab once the project loads./
15. Add a PEM Electrolyzer to the PRODUCT STORAGE area. Right click on the area and select **Equipment Model Library** from the component browser.



16. Enter *PEM Electrolyzer* as the component name and click **OK**.
17. Select the library file EX\_Electrolyzer and click **OK**, then select the item PEM1 (PEM Electrolyzer) and click **OK**.



18. Enter the following specifications in the component PEM Electrolyzer form.

<b>Tag</b>	<b>PEM-100</b>
<b>Capacity</b>	<b>6,000 KVA [6 MEGAW]</b>

19. **Apply** your changes. Once you hit the Apply button, ACCE will use the library data to calculate material equipment cost, setting labor hours and weight for the electrolyzer. These results are visible in the same component form.




## Task 3 - Evaluate the Electrolyzer and Explore Reports

20. Click on **Tools | Options | Preferences** and go to the **Reporting** tab, set the Item Report to be the **Reporter Report**.

The screenshot shows the 'Preference' dialog box with the 'Reporting' tab selected. The 'Item Report' section at the bottom has three radio button options: 'HTML Item Report', 'Capital Cost Item Report', and 'Reporter Report'. The 'Reporter Report' option is selected and highlighted with a red rectangular box. Other sections include 'SQL Server Information' with a text field containing '(LocalDB)MSSQLLocalDB\_EEV14' and a 'Test Connection' button, and 'Excel report options' with three radio button options: 'Always overwrite previously run Excel reports' (selected), 'Append to the existing Excel reports', and 'Prompt for selection dialog'.

21. Run a single item evaluation by clicking the **Evaluate** button in the Electrolyzer component form.
22. Review the **Summary** tab and notice both Equipment and Civil costs were calculated.

**Summary** | General Data Sheet | Installation Details

<i>Project Title:</i> NEW EXPANSION (9SEP12)					
<i>Project Location:</i> HOUSTON, TX <i>Job No:</i> JN0001 <i>Estimate Date:</i> 8JAN24 12:25:13			<i>Prepared By:</i> RO <i>Est. Class:</i> SAMPLE <i>Currency:</i> DOLLARS -\$-		
Single Component Summary					
PEM Electrolyzer Tag No. PEM-100	Direct Installed MH and Costs				Component ID 32  Weight
	MH	Labor	Matl	Total	
(2) Equipment	460	16,752	7,600,000	7,616,752	46,000 LBS
(4) Civil	241	6,807	6,244	13,051	2,881 LBS
<b>Component Totals</b>	<b>701</b>	<b>23,559</b>	<b>7,606,244</b>	<b>7,629,803</b>	<b>48,881 LBS</b>

23. Switch to the **Installation Details** tab. Review all costs associated to the electrolyzer foundation.

PEM Electrolyzer (ID: 32)		Direct Installed MH and Costs					
Location	COA Description	Item Description	Quantity	MH	Labor	Matl	Total
GENERAL	(103) Special Plant Item	PEM Electrolyzer	1 (ITEM/S)	460	16,762	7,600,000	7,616,762
LG BLOCK	(447) Excavation	MACHINE EXCAVATION	49 CY	7	177		177
LG BLOCK	(447) Excavation	HAND EXCAVATION	1 CY	5	98		98
LG BLOCK	(458) Backfill	EXCAVATED SOIL	29 CY	2	34		34
LG BLOCK	(448) Concrete Pour And Finish	SEAL SLAB - TYPE A CONC	1 CY	7	179	56	234
LG BLOCK	(444) Concrete	READY-MIX CONC. - TYPE B	22 CY			2,195	2,195
LG BLOCK	(448) Concrete Pour And Finish	POUR AND FINISH CONCRETE	22 CY	40	1,029		1,029
LG BLOCK	(454) Formwork Materials	CONTACT SURFACE FORMWORK	335 SF			201	201
LG BLOCK	(454) Formwork Materials	BRACING FORMWORK	927 BR3 FT			316	316
LG BLOCK	(455) Field Fabricate Formwork	FORMWORK FABRICATION	335 SF	39	1,092		1,092
LG BLOCK	(456) Install Formwork	FORMWORK INSTALLATION	335 SF	40	1,104		1,104
LG BLOCK	(457) Strip & Clean Formwork	STRIP AND CLEAN FORMWORK	335 SF	16	442		442
LG BLOCK	(451) Rebar	REBAR INSTALL - TYPE S	1 TONS	39	1,302	1,756	3,859
LG BLOCK	(445) Grout	GROUT	0 CY	29	774	761	1,535
LG BLOCK	(452) Foundation Accessories	ANCHORS AND EMBEDMENTS	372 LBS	29	579	958	1,534
<b>Component Totals</b>				<b>701</b>	<b>23,598</b>	<b>7,606,244</b>	<b>7,629,803</b>

Since equipment weight data was added to the library, ACCE will be able to perform basic calculations for the equipment's foundation. If weight data is not provided, ACCE will not calculate any foundation.

24. **Close** the current report and return to the component form for PEM-100.

25. Locate the cell **PWRDRVR** and enter a value of 30 HP [22 KV].

Name	Units	Item 1
Equipment class		SE
Equipment type		ELECTROLY
Material		SS
Code of account		103
Icarus/User COA option		
CAPACITY	KVA	6,000
Currency unit for matl cost		
Equipment cost	-\$-	7,600,000
Setting labor hours		460
Equipment weight	LBS	46,000
Equipment setting option		
Design gauge pressure	PSIG	
Design temperature	DEG F	
<b>PWRDRVR</b>	HP	30
Equipment Footprint X	FEET	

26. Click **Apply** and **Evaluate** the component once more.

27. Once the report launches, review the **Summary** tab and notice Electrical costs are now included.

28. Switch to the **Installation Details** tab and review all costs associated to the electrical cabling for the electrolyzer.

Single Component Installation Details				Direct Installed MH and Costs			
Location	COA Description	Item Description	Quantity	MH	Labor	Matl	Total
GENERAL	(103) Special Plant Item	PEM Electrolyzer	1 ITEM(S)	460	16,752	7,600,000	7,616,752
LG BLOCK	(447) Excavation	MACHINE EXCAVATION	49 CY	7	177		177
LG BLOCK	(447) Excavation	HAND EXCAVATION	1 CY	5	98		98
LG BLOCK	(458) Backfill	EXCAVATED SOIL	29 CY	2	34		34
LG BLOCK	(446) Concrete Pour And Finish	SEAL SLAB - TYPE A CONC.	1 CY	7	179	55	234
LG BLOCK	(444) Concrete	READY-MIX CONC. - TYPE B	22 CY			2,195	2,195
LG BLOCK	(446) Concrete Pour And Finish	POUR AND FINISH CONCRETE	22 CY	40	1,029		1,029
LG BLOCK	(454) Formwork Materials	CONTACT SURFACE FORMWORK	335 SF			201	201
LG BLOCK	(454) Formwork Materials	BRACING FORMWORK	627 BD FT			316	316
LG BLOCK	(455) Field Fabricate Formwork	FORMWORK FABRICATION	335 SF	39	1,092		1,092
LG BLOCK	(456) Install Formwork	FORMWORK INSTALLATION	335 SF	40	1,104		1,104
LG BLOCK	(457) Strip & Clean Formwork	STRIP AND CLEAN FORMWORK	335 SF	16	442		442
LG BLOCK	(451) Rebar	REBAR INSTALL - TYPE S	1 TONS	39	1,302	1,756	3,059
LG BLOCK	(445) Grout	GROUT	0 CY	29	774		1,535
LG BLOCK	(452) Foundation Accessories	ANCHORS AND EMBEDMENTS	372 LBS	20	575	959	1,534
MOTOR	(711) Wire/Cable - LV	8 AWG 600 V	1,020 FEET			813	813
MOTOR	(711) Wire/Cable - LV	PULL IN CON 600V 8AWG	1,020 FEET	14	464		464
MOTOR	(715) Terminators/Connectors	8 AWG LV-TERM	6 EACH	5	175	188	363
MOTOR	(721) Conduit	0.75 IN DIA CONDUIT	330 FEET			759	759
MOTOR	(721) Conduit	INSTALL CONDUIT 0.75IN	330 FEET	50	1,762		1,762
MOTOR	(722) Conduit Fittings	0.75 IN DIA ELBOWS	4 EACH	1	20	19	38
MOTOR	(722) Conduit Fittings	0.75 IN DIA FITTINGS	3 EACH	2	86	43	130
MOTOR	(722) Conduit Fittings	0.75 IN DIA UNIONS	8 EACH	4	138	30	168
MOTOR	(722) Conduit Fittings	0.75 IN DIA SEALS	3 EACH	2	74	60	134
MOTOR	(722) Conduit Fittings	0.75 IN DIA COUPLNG	10 EACH	1	49	19	69
MOTOR	(722) Conduit Fittings	0.75 IN DIA BUSHING	2 EACH	1	25	4	29
MOTOR	(714) Push Button Station	PUSHBUTTONS PILOT LIGHTS	2 EACH	11	373	707	1,080
PUSHB	(718) Wire/Cable - CV	14 AWG 600 V	1,440 FEET			392	392
PUSHB	(718) Wire/Cable - CV	PULL IN CON 600V 14AWG	1,440 FEET	12	406		406
PUSHB	(715) Terminators/Connectors	14 AWG CV-TERM	8 EACH	5	186	191	377
PUSHB	(721) Conduit	0.75 IN DIA CONDUIT	350 FEET			805	805
PUSHB	(721) Conduit	INSTALL CONDUIT 0.75IN	350 FEET	54	1,869		1,869
PUSHB	(722) Conduit Fittings	0.75 IN DIA ELBOWS	4 EACH	1	20	19	38
PUSHB	(722) Conduit Fittings	0.75 IN DIA FITTINGS	3 EACH	2	86	43	130
PUSHB	(722) Conduit Fittings	0.75 IN DIA UNIONS	8 EACH	4	138	30	168
PUSHB	(722) Conduit Fittings	0.75 IN DIA SEALS	3 EACH	2	74	60	134
PUSHB	(722) Conduit Fittings	0.75 IN DIA COUPLNG	11 EACH	2	54	21	76
PUSHB	(722) Conduit Fittings	0.75 IN DIA BUSHING	2 EACH	1	25	4	29

This example PEM library includes a field corresponding to a Descriptive Parameter which uses the UOM info to automatically generate electrical bulks. If left empty, ACCE will not generate any cables/wires. Note that even though some of these bulks are labeled as MOTOR, there are no actual additional motors included in the estimate.

29. Close the PEM-100 report.

30. Evaluate the full project. Ignore any warning messages that may appear.

31. Open the following **Standard** reports:

- **Capital Cost Reports | Direct Costs | Cost / Quantity Rollups | Component (Maxiblock)**
- **Other Reports | Project | Component Listings | Sorted by Installed Cost (Descending)**

32. Locate the PEM Electrolyzer in both reports, you can use the tag (PEM-100) and the search box in the reports to make the search easier.

Component / Source / Tag No.		Direct Installed MH and Costs						
Account	Key Qty	Unit MH	MH	Wage Rate	Labor Cos	Unit Matl	Matl Cost	Total Cost
<b>OYHDS. STORAGE TANK VT-108</b>		ID:	16	Direct Installed Cost Multiplier = 2.15				
Pipe Insulation	542 FEET	0.43	234	26.87	6,283	17.17	9,301	15,584
Equip Insulation	7,691 SF	0.23	1,763	26.78	47,225	7.21	55,433	102,658
Paint	18,132 SF	0.05	972	27.07	26,320	0.48	8,775	35,094
<b>Component / Source Totals</b>			<b>7,130</b>		<b>202,320</b>		<b>664,271</b>	<b>866,590</b>
<b>PEM Electrolyzer PEM-100</b>		ID:	33	Direct Installed Cost Multiplier = 1.01				
Equipment	1 ITEM(S)	460.00	460	36.42	16,752	7,600,000	7,600,000	7,616,752
Concrete	22.0 CY	9.69	213	28.36	6,033	250	5,483	11,516
Grout	0.2 CY	167.65	29	27.15	774	4,477	761	1,535
AG Electrical	2,460 FEET	0.07	173	34.81	6,022	1.71	4,207	10,230
<b>Component / Source Totals</b>			<b>874</b>		<b>29,582</b>		<b>7,610,451</b>	<b>7,640,033</b>
<b>PERIMETER FENCING SD-201</b>		ID:	29					
Other Sitework	1 LS		1,118	25.56	28,568		28,991	57,559
<b>Component / Source Totals</b>			<b>1,118</b>		<b>28,568</b>		<b>28,991</b>	<b>57,559</b>

33. Open the following Excel report:

- Other Reports | Project | Equipment Summary

34. Locate the PEM Electrolyzer and review cost results.

## Conclusion

When estimating electrolyzer units, there are a number of possibilities and variables to consider when trying to define the specifications of an electrolyzer. Regardless of all these possibilities, ACCE provides the capability to rigorously estimate these units along with their required installation bulks using Equipment Model Libraries. Be it a PEM type as shown in this guide or an alkaline type, the same method can be used to estimate these units.

The key to obtaining a reliable estimate is to keep consistency in the pricing data that is saved in ACCE, as well as selecting the most appropriate correlation between equipment capacity and its cost. In order to correctly estimate the corresponding installation bulks for electrolyzers, always consider the following:

- By default: Users cannot select a P&ID for EML items in a project.
  - Please contact Aspen Tech for more information on how to attach a Volumetric P&ID to an EML item.
- Piping and instrumentation bulks for EML items are not generated by default.
- The only bulks generated are:
  - Civil (Foundation) if weight is specified
  - Electrical (Motor wiring) if PWRDRVR parameter is specified.



### **About Aspen Technology**

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in capital-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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