U.S. DEPARTMENT OF ENERGY

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Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

CCSI Technology Readiness Levels Likelihood Model (TRL-LM) User's Guide

DW Engel
AC Dalton
C Sivaramakrishnan
C Lansing

March 2013

Pacific Northwest NATIONAL LABORATORY

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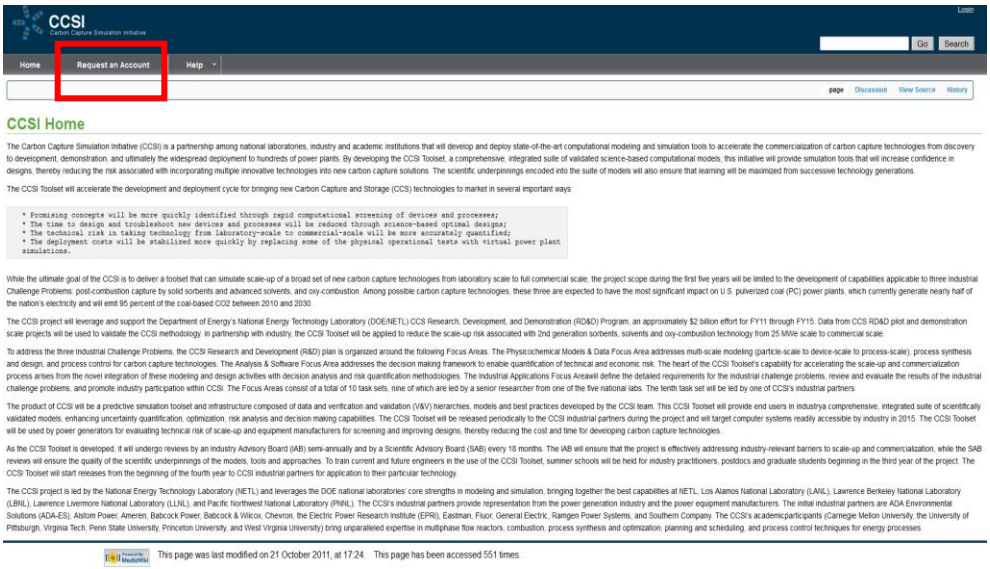
Pacific Northwest National Laboratory
Richland, Washington 99352

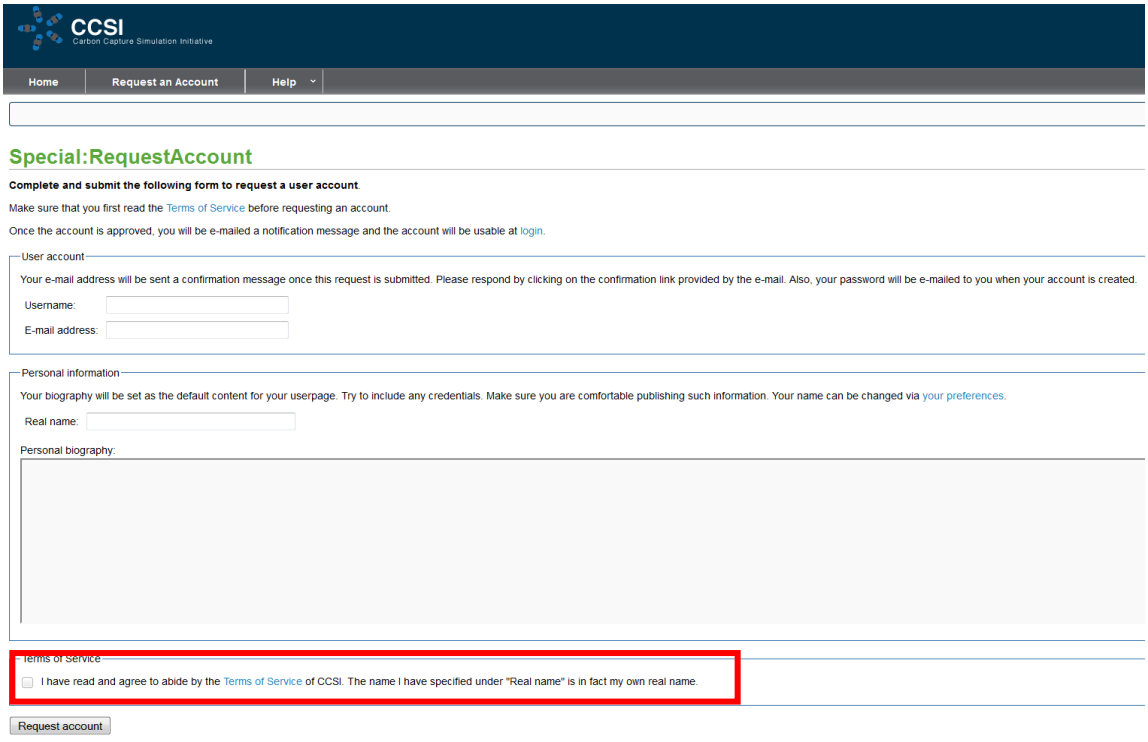
I. Request and Create a New User Account

1.1. After successful installation, the user will need an account in order to use the TRL-LM. To do so, go to CCSI homepage, and click on the “Request an Account” tab.



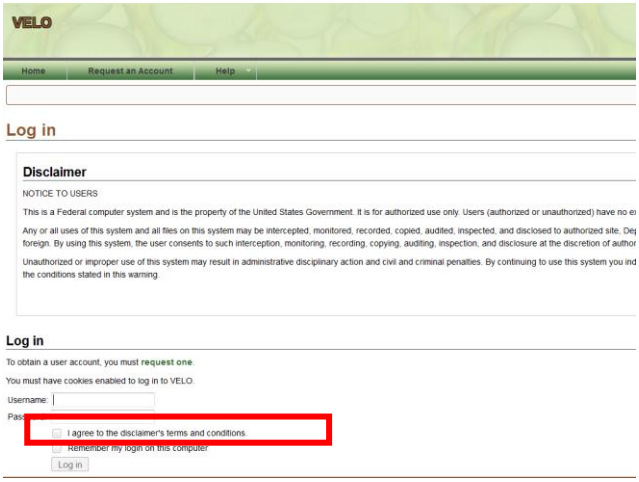
1.2. Create an Account

Follow the instructions to request an account by entering all the necessary information. Make sure to read the terms of service and check the appropriate box before requesting an account.

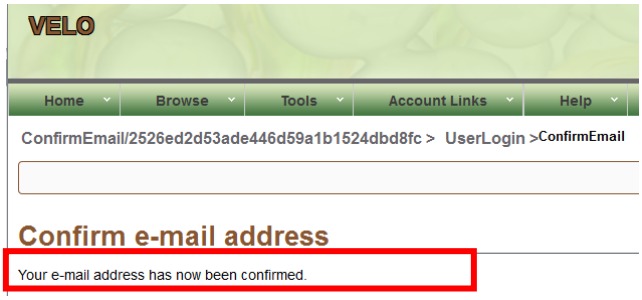


1.3. The user will receive an email confirmation and will be required to activate the account by clicking on the link in the email. A new page will appear; click on the “Request an Account” tab.

1.4. Log in with the user name and password. Be sure to check the box next to “I agree to the disclaimer’s terms and conditions.”

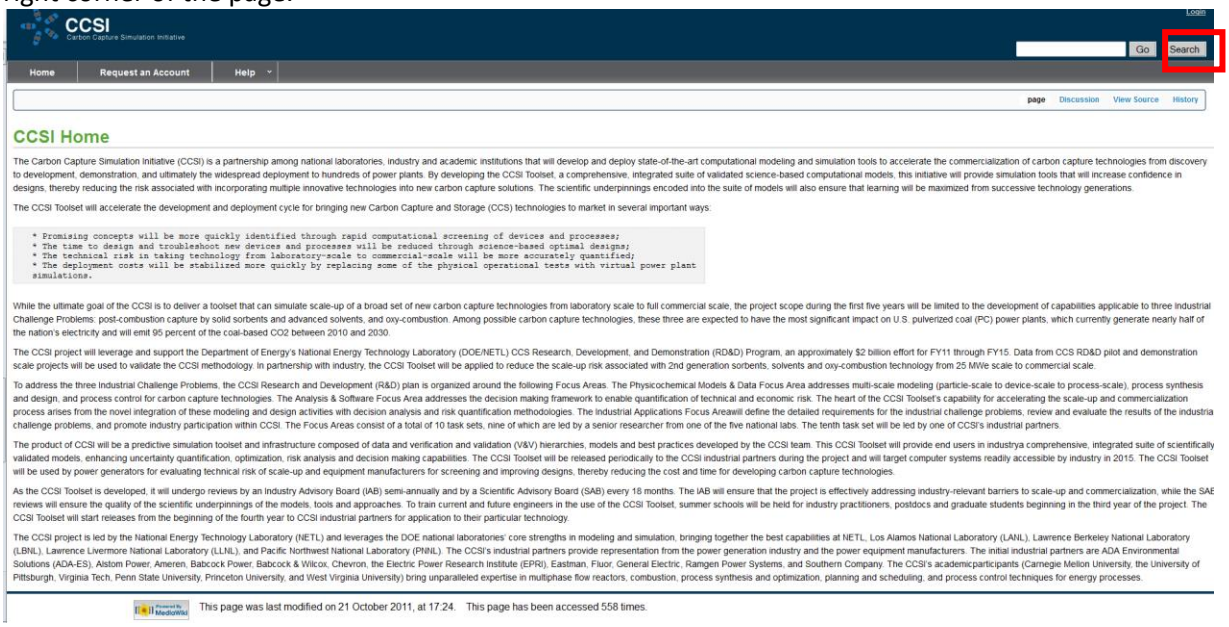


1.5. The screen will indicate that the user’s e-mail address has been confirmed. The user can proceed to CCSI home page and navigate to TRL-LM.

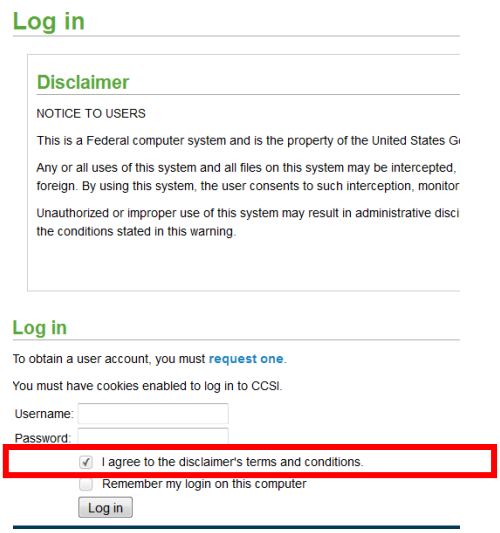


II. TRL-LM: Questionnaire and Results

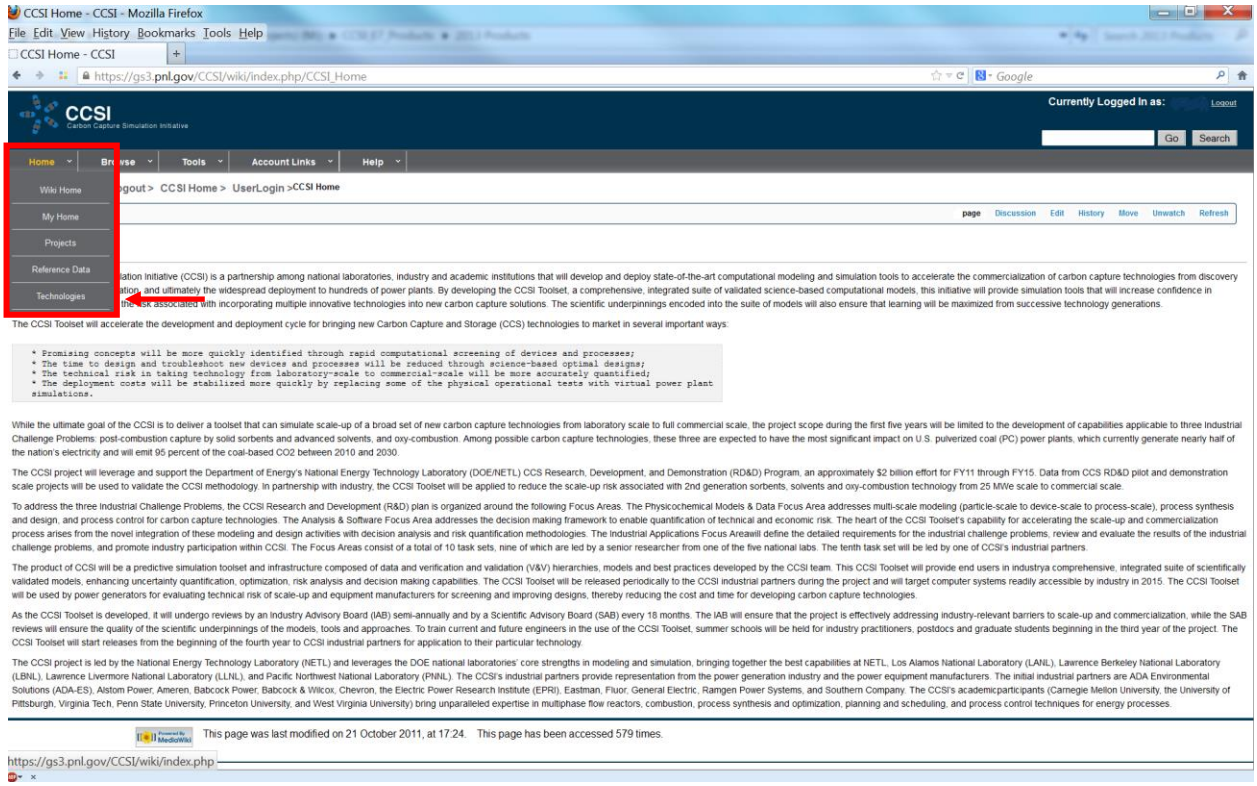
2.1. To access TRL-LM, go to CCSI homepage and log in by clicking on the "Login" button in the upper right corner of the page.



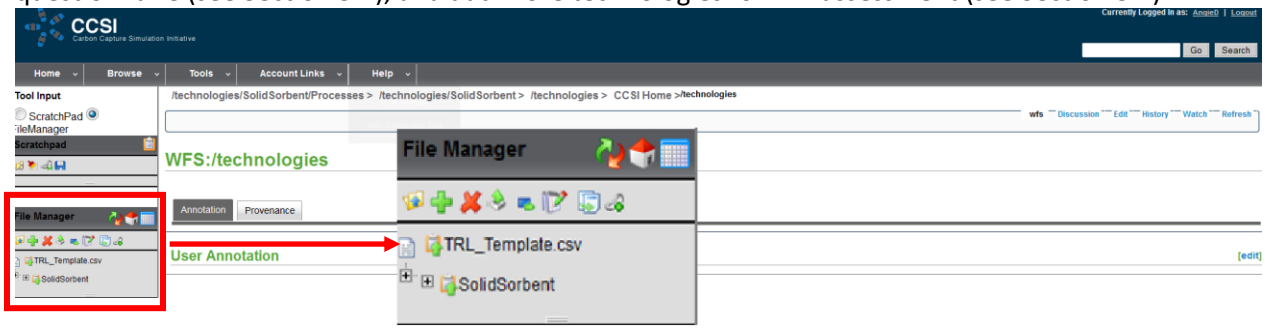
2.2. On the login page, enter the user name and password. Make sure to read and agree to the disclaimer's terms and conditions.

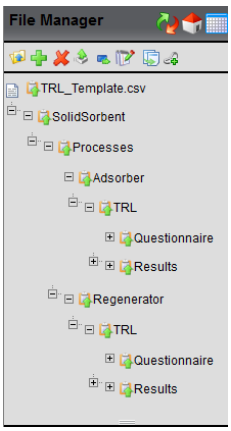


2.3. Once logged in, hover the mouse over the "Home" tab, and select "Technologies" from the drop-down list to navigate to the TRL-LM page.



2.4. Locate “File Manager” on the left side of the screen. Under the file manager, two items are listed: TRL_Template.csv and SolidSorbent. The csv template contains all the questions and descriptions that will be displayed in the TRL questionnaire, and it sets the default format for the questionnaire. Solid Sorbent is a technology for which readiness assessment is sought. The user can modify the questionnaire (see Section 3.1), and add more technologies for TRL assessment (see Section 3.2).

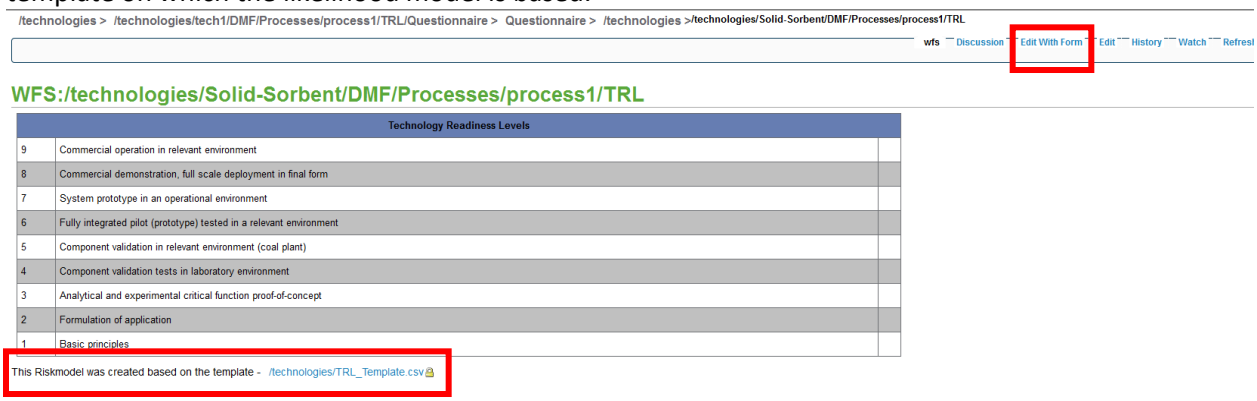




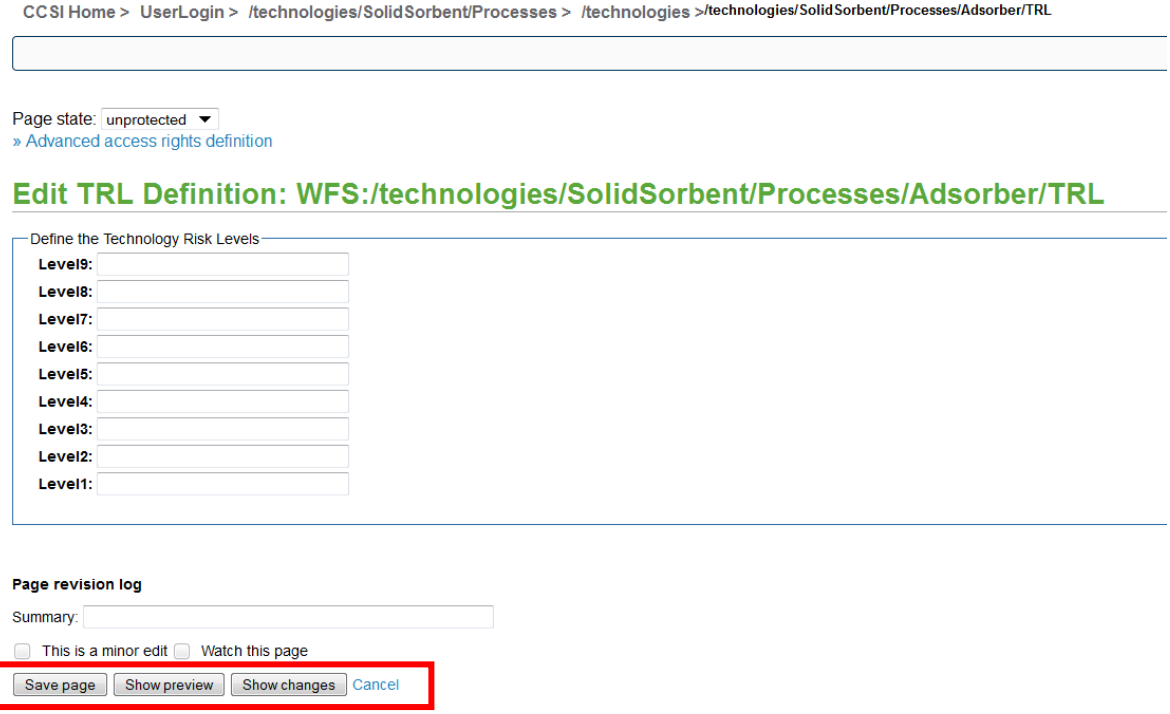
2.5. Click on the plus symbol next to “Solid Sorbent” to unfold and view the TRL-LM file directory structure. For each technology, there is a “Processes” folder to accommodate one or more processes within a technology. For example, for the solid sorbent based carbon capture technology, we focus on two processes: adsorber and regenerator. See Section 3.2 for instructions on how to add more processes to a technology. Within each process, there is a technology readiness level (TRL) folder containing a Questionnaire folder, and a Results folder. The questionnaire elicits comments and responses from users, and the results

component calculates the TRL likelihood distributions based on users' responses for a given process within a technology.

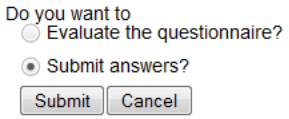
2.6. Click on the "TRL" folder under "File Manager", the user will be directed to the Technology Readiness Levels table where nine TR levels are listed. The text below the table indicates the specific template on which the likelihood model is based.



2.7. If the user wishes to modify the table, click on the "Edit With Form" button as shown in the figure above. A blank table will appear, allowing the user to enter new text that adds specific conditions for each TR level. The "Page revision log" enables the user to document changes made to the table, and to save, preview, show, or cancel the changes by clicking on one of the four tabs.

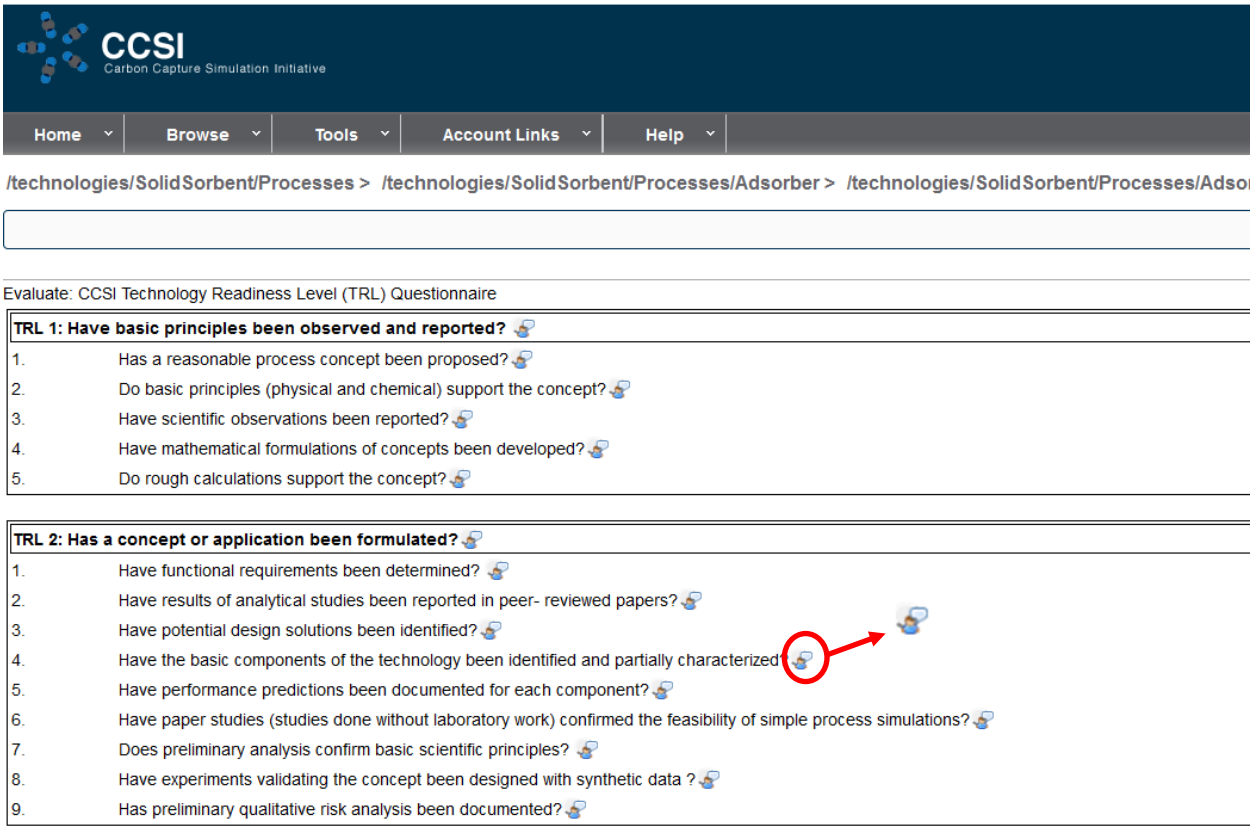


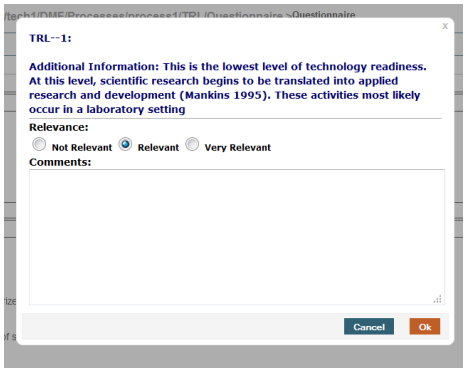
2.8. To view the TRL questionnaire, click on "Questionnaire" under "File Manager". The user will be prompted to make a selection from two options:



- **Evaluate the questionnaire**: allows the users to evaluate the relevance of each question, and provide comments about the questions.
- **Submit answers**: allows the user to respond to the Yes/No questions in the questionnaire and submits the answers. Submission will feed into the Results section to support the calculation of technology readiness level likelihood assessment.

2.9. If choosing "**Evaluate the questionnaire**," the user will be directed to a questionnaire page that is intended for eliciting feedback and critique about the *questionnaire itself*. The design of the questionnaire follows the nine levels of technology readiness illustrated in the TRL table described in Section 2.6. Under each level, a series of questions specific to that TRL are listed. At the end of each question there is a small blue icon. The user can click on the icon to open a small window and provide evaluation.

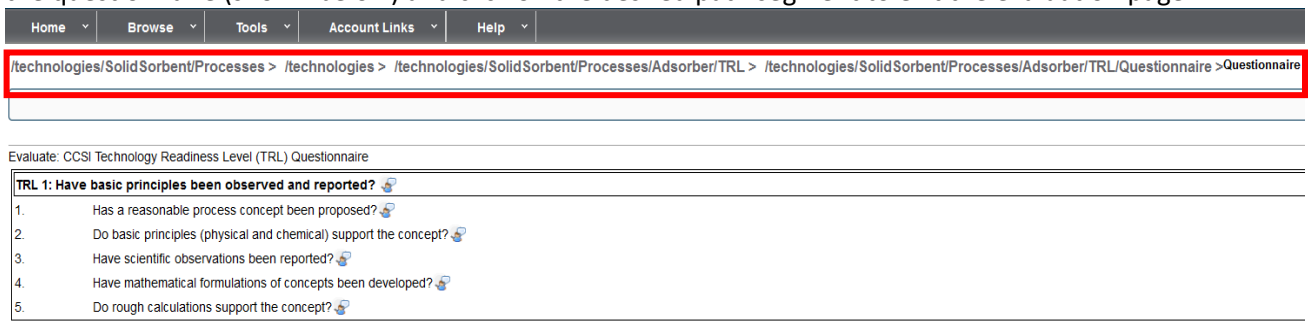




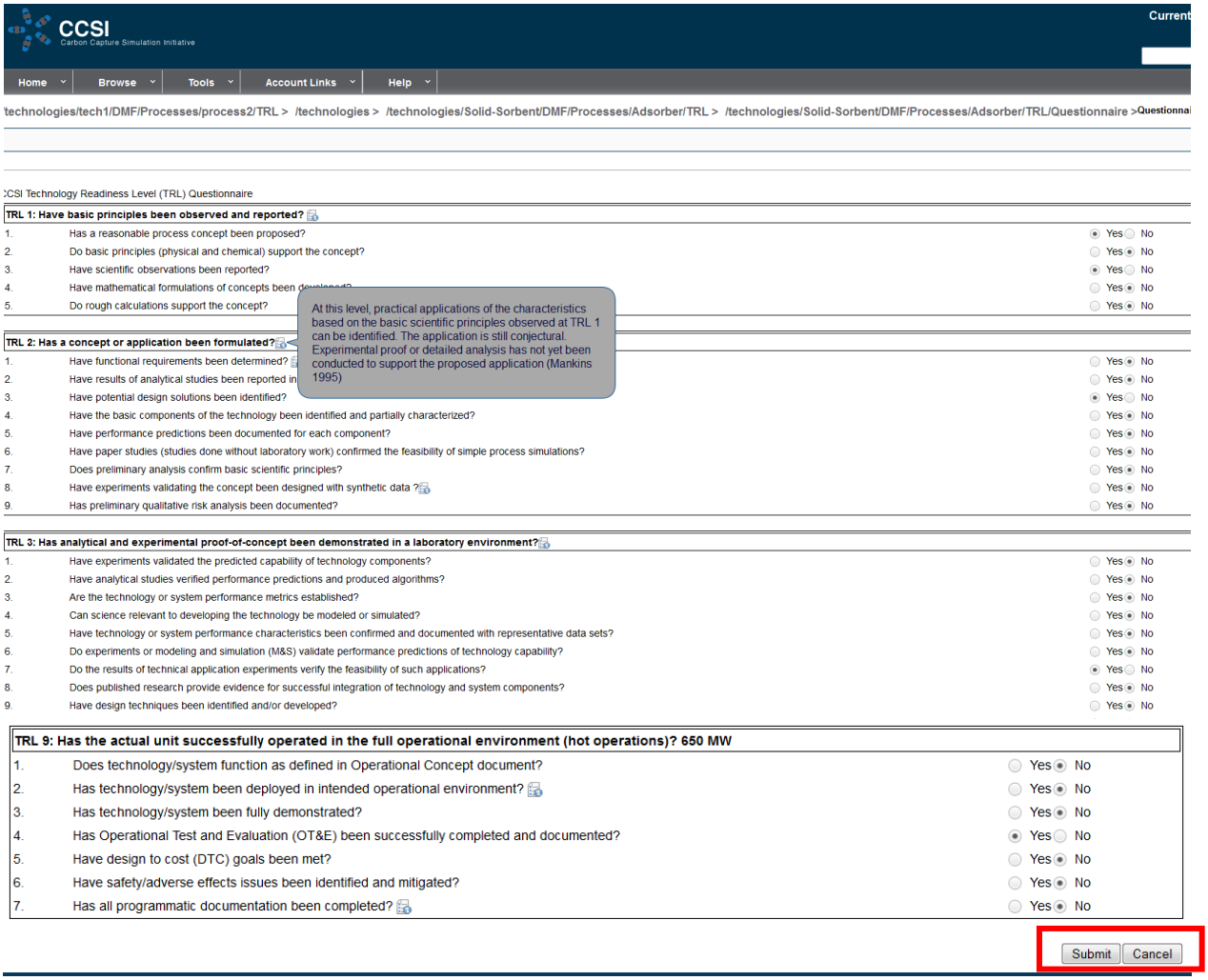
The small window asks the user to rate the relevance of each question by choosing from **Not Relevant**, **Relevant**, and **Very Relevant**. Wherever appropriate, the window also provides a description for each of the nine technology levels, additional information about technical terms used in the elicitation questions, and a comment box where modification suggestions can be entered. The user can save their input by clicking on the "OK" button or cancel their input by clicking on the "Cancel" button.

Upon completion of the evaluation, the user can exit the evaluation page by clicking on the "Go back one page" arrow

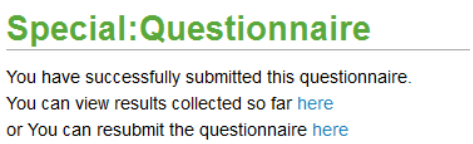
in the address bar on the browser; or by locating the “bread crumbs”, i.e. the directory path listed above the questionnaire (shown below) and click on the desired path segment to exit the evaluation page.



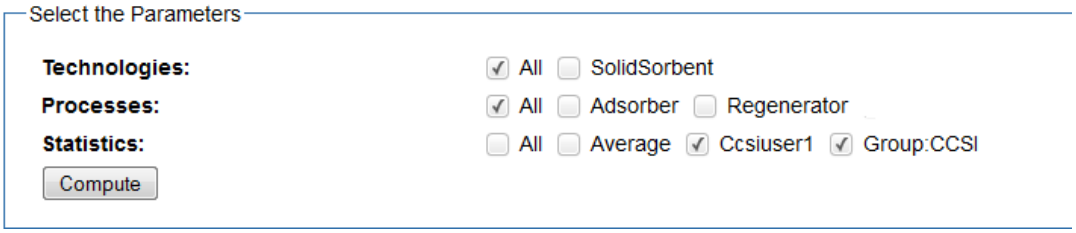
2.10. If choosing “**Submit answers**,” the user will be directed to the questionnaire that is intended to provide input/data for the TRL likelihood model. To that end, the user will respond to the questions by clicking on the Yes/ No radio buttons at the end of each question. The blue icons similarly provide the definition for each of the nine technology readiness levels and definitions of terminology wherever needed. Users need to mouse-hover over the icon to view the information. Upon completion, the user needs to submit the responses by clicking the “Submit” button or cancel the responses by clicking on the “Cancel” button.



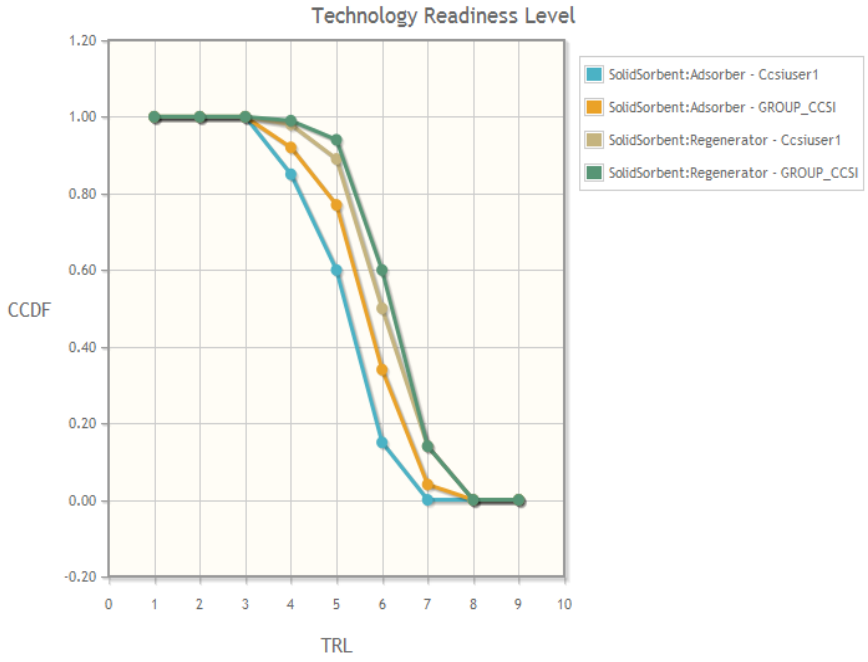
2.11. Once submitted, the user will be directed to a new page with two options: (a) to view results collected up to that point; or (b) resubmit the questionnaire. The user can choose either option by clicking on the links provided.



2.12 If choosing to view the results, the user will be directed to the results page and prompted to select the parameters on which the results are computed. The parameters are grouped by **technologies**, **processes**, and **statistics**. Within each parameter group, the aggregate (shown as "All") and all its constituent components are available for selection. In particular, "statistics" computes the mean (average) for all the users who have submitted responses, and for the user who is viewing the results as well as for each TRL-LM user group. In the example below, the user "Ccsiuser1" is the individual user who submitted his/her responses and is viewing the results, at the same time this user is a member of the CCSI Group. The scope of viewing privileges is based on the user's role and group membership. Since user grouping is implemented by the administrator, it is important to communicate accurate role and group membership information with your administrator when requesting/createing a new user account.



Once the appropriate parameters are chosen, click on the "Compute" button and a Technology Readiness Level diagram will be displayed. The legend represents all the chosen parameters. The X-axis represents the technology readiness level scale, ranging from 1 to 9 while the Y-axis is the complementary cumulative distribution function (CCDF), ranging from 0 to 1. A corresponding probability distribuiton table is also displayed to provide numeric values captured by the digram. The table can be downloaded as a .csv file.



Download results as .CSV file

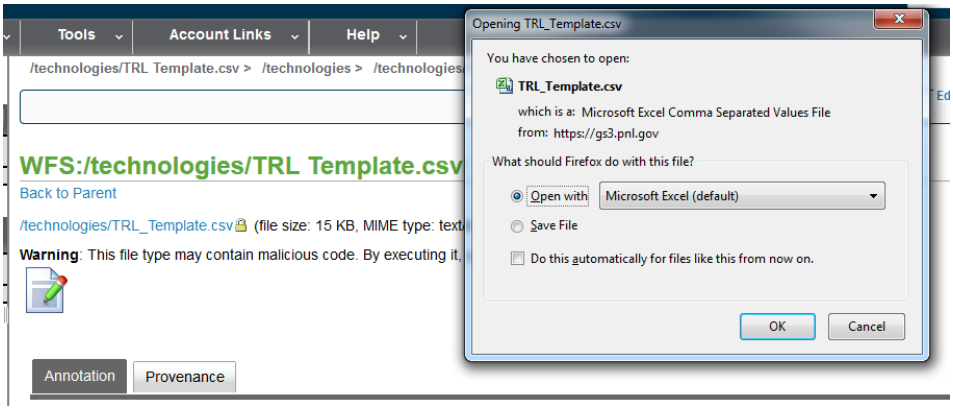
Technology	Process	Statistics	TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
SolidSorbent	Adsorber	Ccsiuser1	1.00	1.00	1.00	0.85	0.60	0.15	0.00	0.00	0.00
SolidSorbent	Adsorber	GROUP_CCSI	1.00	1.00	1.00	0.92	0.77	0.34	0.04	0.00	0.00
SolidSorbent	Regenerator	Ccsiuser1	1.00	1.00	1.00	0.98	0.89	0.50	0.14	0.00	0.00
SolidSorbent	Regenerator	GROUP_CCSI	1.00	1.00	1.00	0.99	0.94	0.60	0.14	0.00	0.00

III. Customization Capabilities for Portfolio Management

3.1 Template Modification

Although the questionnaire is based on the default template, TRL-LM provides template modification and upload options if the user decides to modify the current template or use a different template. To do so, the user needs to navigate back to the File Manager and click on "TRL_template.csv." The user will then be directed to a new page containing the default csv template file.

Click on the csv file name, the user will be prompted to log in again in order to save the file. Once saved, the template can be modified according to the user's preference and/or the characteristics of the specific industry/research domain of interest.



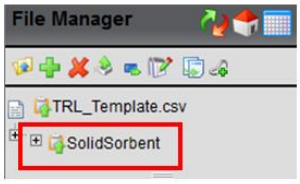
3.2 Uploading a New Template to TRL-LM

To upload a modified or new template to the TRL-LM interface, the user needs to navigate to the specific *process* where a different TRL questionnaire template is required. In the following example, we plan to add a new process to the Solid Sorbent technology, which already has two processes: Adsorber and Regenerator.

The user needs to follow the steps below to upload a template.

(1) Locate the File Manager and click on “Processes”.
(2) The user will be directed to a new page displaying the two existing processes.
(3) Locate the File Manager and click on the create icon (green plus sign).
(4) A new window will appear, asking the user to specify the content of the new creation. The dropdown list provides two options: Collection and Process. Collection refers to a free-standing directory or file folder used to store any project reference documents, manual, etc. that are associated with a process.
(5) The user chooses “Process” from the drop-down list and names the process “Conveyor”. The user is prompted to upload a different TRL template file by clicking “Browse” and then clicking “Create” to complete the creation command. If the user prefers to use the default template, skip the browsing step and simply clicks “Create”.
(6) Once the operation is complete, the user should see “Conveyor” under the File Manager as a parallel folder to Adsorber and Regenerator. Note, by creating a new process, the TRM-LM automatically generates an associated TRL folder, a questionnaire, and a Results folder.

1



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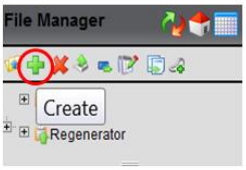
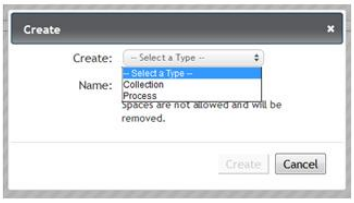


4



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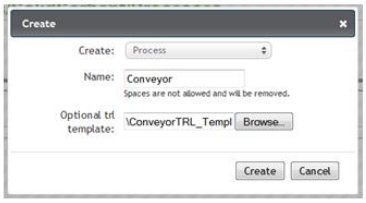
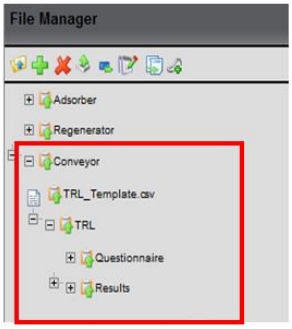


6

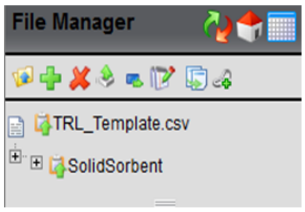


3.3. Adding a New Technology to TRL-LM

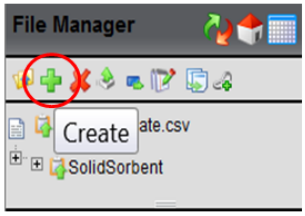
To add a new technology to TRL-LM, follow the procures below.

1) Navigate to the File Manager on the main page. In the example, there is one technology currently in the TRL-LM.
2) Click on the “Create” icon (green plus sign).
3) A new window will appear, prompting the user to specify what to create. The drop-down list offers two options: Creation and Technology.
4) Choose “Technology” and enter a name for the new technology. In this example, we enter “Liquid Solvent”. If the user prefers to upload a different template than the default, click on the “Browse” button to retrieve and upload the template file. If using the default template, skip this step, and then click on the “Create” button to complete the process.
5) Upon completion, the new technology will be displayed under the File Manager as a parallel folder to Solid Sorbent. Notice, when creating a new technology, TRL-LM creates a new folder for the technology and automatically generates a “Processes” folder for it **WITHOUT** also generating an associated TRL folder, a questionnaire, and a Results folder for the new technology. To add these folders to a newly added technology, follow Section 3. 2.
6) In this example, we add a process, MEA, to the Liquid Solvent technology and fill out the TRL questionnaire for MEA.

1



2



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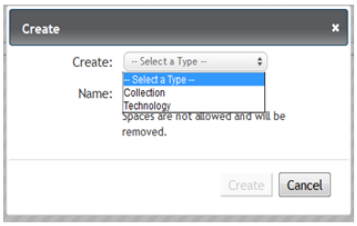
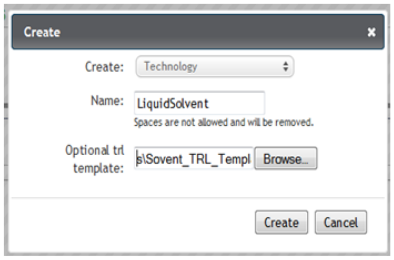
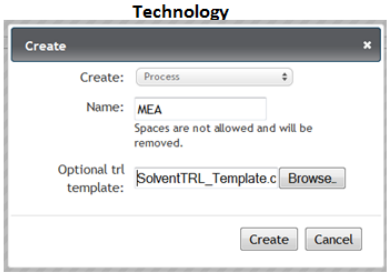


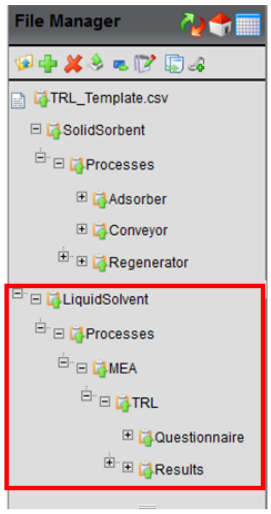
4. Add Liquid Solvent Technology



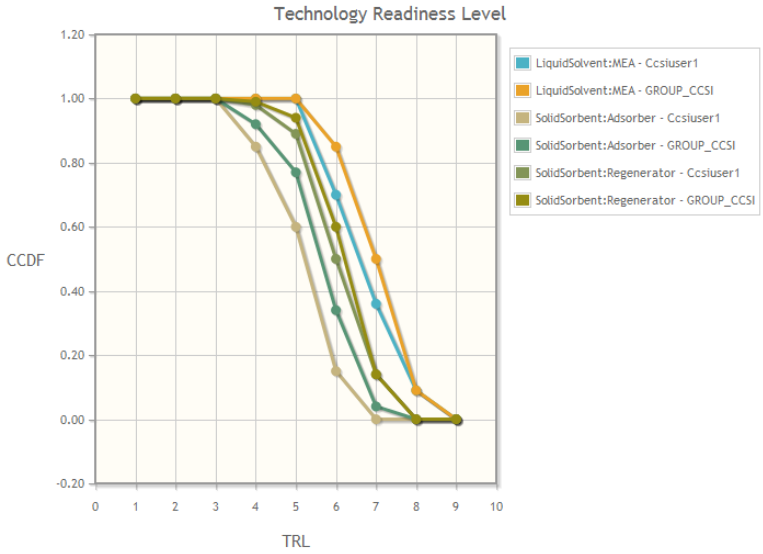
5. Add MEA to Liquid Solvent Technology



6. All Technologies and Processes



After adding new technologies and processes, users can proceed to provide answers to the questionnaires that are tailored specifically for these new additions. To review the TRL-LM results for all, go to File Manager, click on Questionnaire under TRL for any process or technology. Click “Submit Answers” to fill out the questionnaire. Then click “Submit” to submit your responses. On the new page, select “view results collected so far”. On the view results page, select the appropriate parameters. Select “All” to view the results for all the technologies and processes included in the TRL-LM. As, the following figure shows, the TRL-LM diagram and the results table display every technology and process that is included in the TRL-LM. As the results demonstrate, the liquid solvent technology is relatively more mature than the solid sorbent technology. Within the solid sorbent technology, the technology readiness level varies from one process to another.



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Technology	Process	Statistics	TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
LiquidSolvent	MEA	Ccsiuser1	1.00	1.00	1.00	1.00	1.00	0.70	0.36	0.09	0.00
LiquidSolvent	MEA	GROUP_CCSI	1.00	1.00	1.00	1.00	1.00	0.85	0.50	0.09	0.00
SolidSorbent	Adsorber	Ccsiuser1	1.00	1.00	1.00	0.85	0.60	0.15	0.00	0.00	0.00
SolidSorbent	Adsorber	GROUP_CCSI	1.00	1.00	1.00	0.92	0.77	0.34	0.04	0.00	0.00
SolidSorbent	Regenerator	Ccsiuser1	1.00	1.00	1.00	0.98	0.89	0.50	0.14	0.00	0.00
SolidSorbent	Regenerator	GROUP_CCSI	1.00	1.00	1.00	0.99	0.94	0.60	0.14	0.00	0.00

3.4 Delete Existing Processes and Technologies

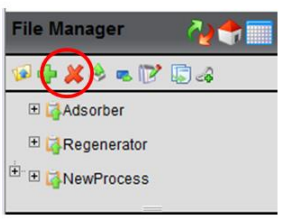
To delete a process and its associated folder,

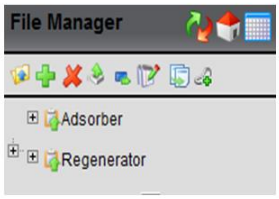
(1) Navigate to File Manager at the process level and click on the delete symbol (red cross).

(2) A small window will appear, asking the user to specify what to delete. Check the appropriate folder(s) (NewProcess is checked in this example), and click “Delete” to complete the deletion process.

(3) The deleted process folder is no longer listed under File Manager.

1 2 3





To delete a technology and its associated folders,

(1) Navigate to File Manager at the technology level and click on the delete symbol (red cross).

(2) A small window will appear, asking the user to specify what to delete. Check the appropriate folder(s)(Liquid Solvent is checked in the example), and click “Delete” to complete the deletion process.

(3) The deleted technology folder is no longer listed under File Manager.

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