

PROGRESS REPORT for EPC-19-060

April 2022

Recipient Project Manager: Sarah Kurtz

Commission Agreement Manager: Jeffrey Sunquist

What we planned to accomplish this period

1. Submit the deliverable for Task 3.4
2. We will continue to meet with stakeholders and community representatives to gather inputs and request feedback
3. We hope to complete the extension of the implementation of the variable time steps to the PSP scenario.
4. We will continue the SWITCH studies #1, #3 and #4. We anticipate that study #1 will be submitted in April and that data will be organized for #3 and #4 to begin writing in May
5. We will prepare the deliverable for Task 5.1.

What we actually accomplished this period

1. Complete Draft Generation Scenario Summary for Task 3.4

The Draft Electricity Grid Scenario Summary was submitted. It is included in this package for reference.

2. Stakeholder and collaborator meetings: During the month of March, we met with:

- Priya Sreedharan of GridLab gave a preview of a report that GridLab is developing (note: the report was released on May 10).
- Roderick Go at E3
- Julia Prochnik of the Long-Duration Energy Storage Association of California.
- Darcy Partners (Lindsay and Mora)
- Simon Pang and Roger Aines of Lawrence Livermore National Lab
- Erin Childs of Strategen

3. Implement variable time steps into RESOLVE code

This month, E3 released multiple modifications to the “New Modeling Toolkit” relative to what we had seen before. Key improvements they shared with us that directly affect our work include (among hundreds of other things):

- Revised file structure that is a little simpler than before (we had suggested this change)
- Additional functionality in terms of being able to define scenarios and easily select details at run time

- Scenario tool to facilitate creation of input files. It now enables creation of the Preferred System Portfolio (PSP)

The changes were in a very positive direction and were nicely done to facilitate our adoption (the inclusion of an expanded data set makes communicating the package more complicated), but the complexity of the software and the extent of the changes required us to take some time to understand the new structure and to revise how our code interacts with their code.

Two primary changes over what we documented in previous monthly reports include the ramp rate modifications and the handling of the profile files.

Ramp rate modification: Specifically for the ramp rate modifications we found that the code we had written to constrain ramp rates for time steps that are not one-hour steps adds something like an hour to run time when a full model (like the PSP) is input. After 1) inspection of the ramp rates that are typically input, 2) reflecting on the fact that longer time steps will almost never be limited by ramp rate so our added code is unlikely to make much difference, and 3) realizing that the critical-time-steps calculation is meant to estimate the capacity expansion plan and that we will then confirm the adequacy of that plan by recalculating the hourly dispatch, we decided that it is unlikely to create a problem if we remove the code modification we had planned. This is a trivial solution to the problem.

File structure: E3 continues to refine the arrangement of the files and has developed a strategy for implementing large quantities of data without overloading the GitHub repository. The profiles that previously were under the resources folder are now placed in a large “profiles” folder that can then be downloaded separately from a Box folder. We must now modify our code to look through that large folder to find the appropriate files to be modified for the critical time points calculation.

We are still working on making all of these changes. Here we share the progress we have made in running the Preferred System Portfolio as created for us by the Scenario Tool, then modified to run 8760 hours for the year of 2007. The charging and discharging of the lithium ion batteries is shown in Fig. 1.

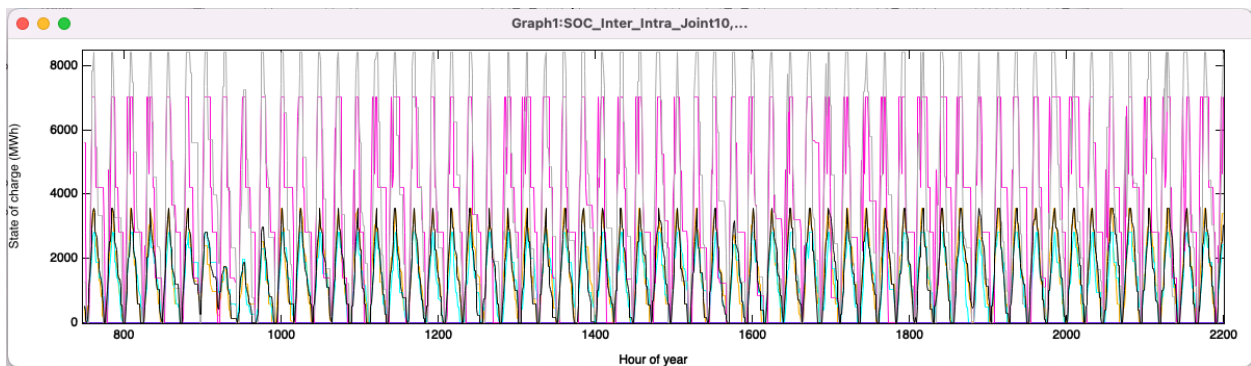


Fig. 1. State of charge for lithium-ion batteries as a function of day of year number for PSP run for 2007 weather data.

While the lithium-ion batteries charge and discharge almost every day, in contrast, the charging pattern for the pumped hydro shows seasonal behavior, as shown in Fig. 2.

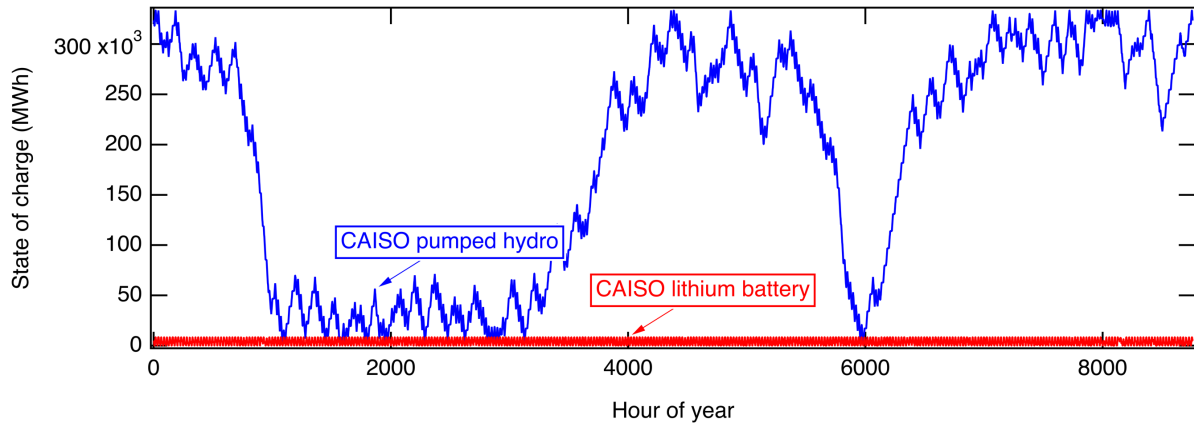


Fig. 2. Comparison of charging patterns of lithium battery and CAISO pumped hydro storage as a function of hour of the year for the PSP run using 2007 weather data.

4. Updates on SWITCH studies #1, #3, and #4 and previous paper updates

From our previous list of papers,

- #6 is now published: P.A. Sanchez-Perez, Martin Staadecker, Julia Szinai, Sarah Kurtz, Patricia Hidalgo-Gonzalez, “Effect of modeled time horizon on quantifying the need for long-duration storage” Applied Energy, vol. 317, 119022, 2022. [Open access](#)

Regarding the SWITCH studies

Study 1:

Staadecker, M. et al, “The value of long-duration energy storage and its interaction with a zero-emissions western North-America electricity grid”

Status: The manuscript is completed and is in the final stages of refinement before submission.

This study has provided us the following two graphs that we believe will be useful in understanding the long-duration storage that is needed for California and WECC (see Figs. 3 and 4).

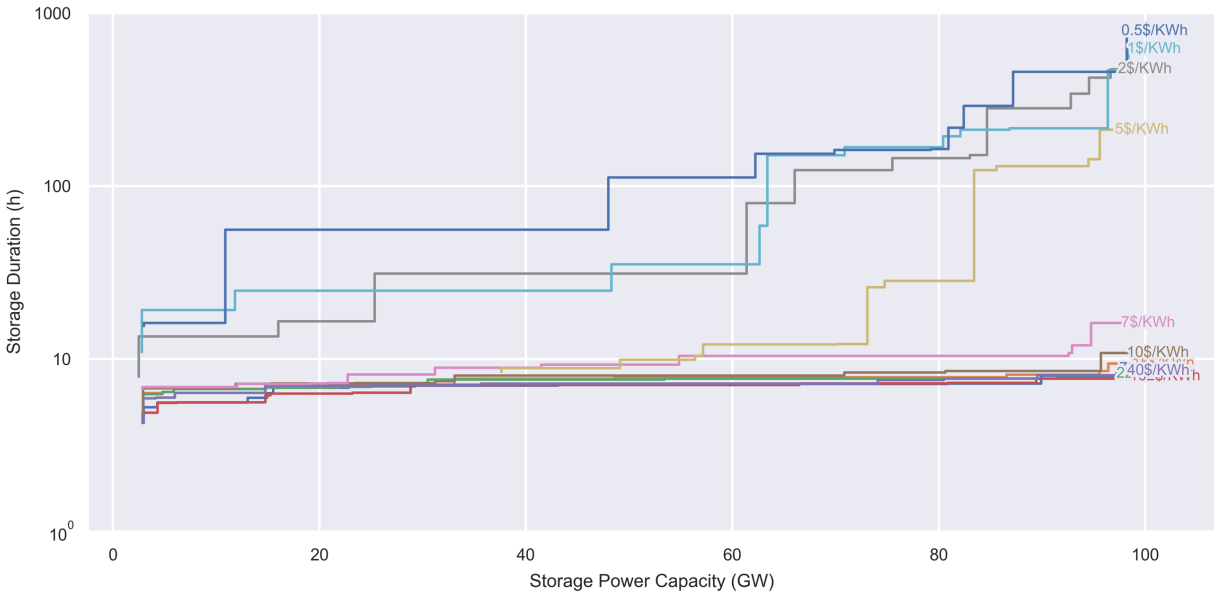


Fig. 3. Long-duration storage selected by the model for California for scenarios (lines in color) using different overnight energy costs (\$/kWh) for the storage, as indicated, and fixed overnight cost for the storage power. The y-axis shows duration and the x-axis cumulative power capacity.

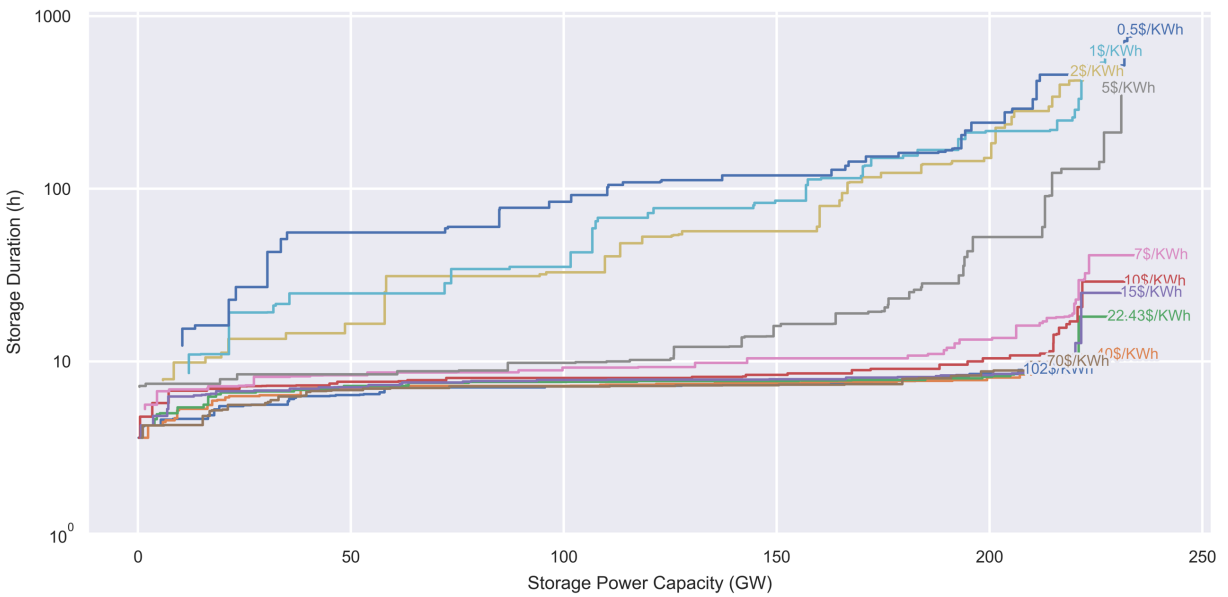


Fig. 4. Long-duration storage selected by the model for the WECC for scenarios (lines in color) using different overnight energy costs (\$/kWh) for the storage, as indicated, and fixed overnight cost for the storage power. The y-axis shows duration and the x-axis cumulative power capacity.

Study 3:

Sanchez-Perez, P. and Serna Torre, P. et al. “Infrastructure and economic opportunities for California to leverage WECC resources to achieve 100% RE by 2045”

The objective of this study is to analyze the benefits in electricity prices and overall cost reduction from allowing imports from outside California. The analysis looks at impacts on supply and storage infrastructure and in-state required generation. Particularly focusing on the impacts related to LDES duration and operation. We perform a systematic study by analyzing capacity expansion optimal results from varying allowed imports in 2050 from 100% (no constraint on imports) and monotonically decreasing allowed imports by 10% all the way down to 0% (California independent from the rest of the WECC).

Status: Ongoing study. We expect to have a manuscript draft by May 2022. The initial findings of this study have revealed more subtleties than we expected (e.g., California might not need to rely on imports by 2050 from a least-cost perspective). Thus, the team has been testing more scenarios and hypothesis to provide meaningful insights to the CEC and the energy community. We aim to understand the benefits (infrastructure and cost) provided by storage in a future where California might not want to depend on imports and other findings related to the value of storage and the coordination (or lack of) between California and the rest of the WECC.

Study 4:

Sanchez-Perez, P., Gonzalez, N., Srivastava, A. and Serna Torre, P. et al. “Impacts of re-designing planning and operational reserves rules on capacity expansion and operation”

The objective of this study is to understand the infrastructure impacts and storage needs of defining reserves in different ways for a zero emissions grid. Ultimately, this study will help regulators understand expected needed storage infrastructure to be able to satisfy reserves requirements as they might evolve over time (2050 reserves requirement design).

More specifically, we are analyzing how the infrastructure and operations would change depending on which technologies are eligible to provide planning reserves (thermal plants, renewables, and storage, or storage only). We have also been studying what are the impacts of modeling subregional planning reserves across the WECC. Last, we plan to study the impact of seasonal requirements for planning reserves.

Status: Ongoing study. We expect to have a manuscript draft by June 2022.

5. Prepare the deliverable for Task 5.1

This is in progress and will be reported on next month.

How we are doing compared to our plan

We have made great progress, but we still have a long way to go.

Significant problems or changes

Invoicing is still behind. We have now completed the invoice through September 2021 and have begun work on an invoice through December 2021. The individual who was doing our invoicing left the university. The person who took over for her had a double workload, so was not able to make fast progress, but she is taking action and we have invited her to join a meeting to discuss any questions about the invoicing process.

The SWITCH part of Task 5.1 is already completed, but the RESOLVE part is behind schedule. E3 released the last elements of the new modeling toolkit in late April. In the update on item #3 above (implementation of the 2-step process), we have made good progress, but have not yet completed and tested the software. We can turn in the deliverable for 5.1 on time, but it will be a more useful document if it is delayed. Also, once that is completed, we will be ready to schedule TAC meeting #3. We are appreciative of the CEC's patience with our efforts.

What we expect to accomplish during the next period

1. Submit the deliverable for Task 5.1
2. We will continue to meet with stakeholders and community representatives to gather inputs and request feedback
3. We will complete the extension of the implementation of the variable time steps to the PSP scenario.
4. We will continue the SWITCH studies #1, #3 and #4. We anticipate that study #1 will be submitted in May and that data will be organized for #3 and #4 to begin writing in May
5. We will prepare the deliverable for Task 5.1.
6. We will prepare for public workshop in July.

Status of Milestones and Products.

Task #	Task	Deliverable	Due date	Status
1.2	Kick-off meeting	Updated budget	9/18/2020	Complete
1.3	CPR Meeting #1	CPR Meeting #1	TBD	
	CPR Meeting #2	CPR Meeting #2	1/21/22	Complete
1.4	Final meeting	Final Meeting	11/11/22	
		Schedule for closeout	11/18/22	

		Draft and Final Written Products	11/18/22	
1.5	Progress Reports & Invoices	Progress Reports	Monthly	Ongoing
		Invoices	Monthly	Ongoing
1.6	Final Report	Draft Outline	6/30/22	
		Final Outline	TBD	
		Draft Report	8/30/22	
		Final Report	10/31/22	
		Written Responses to Comments on Draft Report	9/15/22	
1.7	Match funds	Status letter	9/9/20	Revision submitted
1.9	Subcontracts	Final subcontracts	TBD	Completed
1.10	TAC	List of potential members	9/9/20	Completed
		List of TAC members	TBD	Completed
		Documentation of TAC member commitment	TBD	Completed
1.11	TAC Meetings	Draft TAC meeting schedule	10/1/20	Completed
		TAC meeting 1	11/4/20	Completed
		TAC meeting 2	8/5/21	Completed
		TAC meeting 3	2/3/22	
		TAC meeting 4	11/2/22	
		Note, each meeting need multiple actions		
		Final TAC meeting schedule	TBD	Completed
		Draft TAC meeting agenda	TBD	First one completed
		Backup materials	TBD	First one completed
		Final TAC Meeting agenda	TBD	First one completed
		TAC meeting summaries	TBD	First one completed
2.1	Data assembly	Draft baseline description	2/4/21	Completed
		Final baseline description	2/25/21	Completed
2.2	Confirmation of baseline data and approach	Draft modeling approach description	2/4/21	Completed

		Final modeling approach description	2/25/21	Completed
2.3	Implementation of baseline data into models to create initial baseline scenario	Summary of baseline model results	3/23/21	Completed
		CPR Report #1	15 days prior	Completed
3.1	Evaluate and document future energy storage technology alternatives	Draft storage Technology summary	7/2/21	Completed
		Final storage technology summary	8/12/22	
3.2	Define representative future energy storage technology alternatives	Draft proposed storage scenarios summary	6/1/22	
		Final	8/12/22	
3.3	Evaluate and document future energy electricity generation technology alternatives	Draft electricity generation technology summary	8/2/21	Completed
		Final	8/12/22	
3.4	Define representative future electricity generation technology alternatives	Draft proposed electricity generation scenarios summary	4/1/22	Completed
		Final	8/12/22	
4.1	Multi-day model optimization	Summary of multi-day baseline model results	9/2/21	Completed
		CPR #2	Summer	
4.2	Grid scenario selection	Draft grid scenario summary	2/8/22	Completed
		Final	3/7/22	In progress
5.1	Preliminary Scenario Analysis	Draft preliminary analysis summary	5/31/22	
		Final	TBD	
5.2	Final scenario analysis	Draft final analysis summary	6/10/22	
		Final	8/12/22	
6.1	Initial public meetings	Opening workshop presentation materials	11/17/20	Completed
		Northern CA workshop	12/3/20	Completed
		Southern CA workshop	12/3/20	Completed
		Opening workshop summary	1/8/21	Completed
6.2	Public workshop for grid scenario selection	Agenda	11/2/21	Completed

		Presentation materials	11/2/21	Completed
	Public workshop with CEC and TAC to present proposed scenarios		11/16/21	Completed
		Workshop summary	11/23/21 Summarize public comments: 12/17/21	Completed
6.3	Public workshop for preliminary scenario analysis	Agenda	6/3/22	
		Presentation materials	6/24/22	
	Public Workshop with CEC and TAC to present preliminary analysis		7/7/22	
		Workshop summary	7/21/22	
6.4	Public Workshop for Final Scenario Analysis	Agenda	7/1/22	
		Presentation materials	7/1/22	
	Public workshop with CEC and TAC to present final analysis		7/15/22	
		Workshop summary	7/22/22	
7	Evaluation of Project Benefits	Kick-off meeting benefits questionnaire	9/18/20	Completed
		Final meeting benefits questionnaire	10/14/22	
8	Knowledge transfer activities	Draft initial fact sheet	7/23/20	Completed
		Final initial fact sheet	7/30/20	Completed
		Draft final project fact sheet	7/21/22	
		Final project fact sheet	7/28/22	
		Draft knowledge transfer plan	12/31/20	Completed
		Final knowledge transfer plan	2/26/21	Completed
		Draft knowledge transfer report	8/30/22	
		Final knowledge transfer report	10/31/22	