CHP Modeling in the REopt Lite Web Tool

CID Number GO28308

National Renewable Energy Laboratory, Colorado School of Mines, and Clean Energy Group

Fiscal Year 2019-2021

Kate Anderson, National Renewable Energy Laboratory (NREL)
Patti Garland, DOE Advanced Manufacturing Office

U.S. DOE Advanced Manufacturing Office Program Review Meeting
Washington, D.C.

June 11, 2019

Overview

Project Title: Incorporating CHP Modeling in the REopt Lite Web Tool

Timeline:

Project Start Date: 02/01/2019

Budget Period End Date: 09/30/2021

Project End Date: 09/30/2021

Project Budget and Costs:

Budget	DOE Share	Cost Share	Total	Cost Share %
Overall Budget	$3,015,000	0	$3,015,000	0%
Approved Budget (BP-1&2)	$3,015,000	0	$3,015,000	0%
Costs as of 3/31/19	$108,177	0	$108,177	0%

This project was awarded via a Lab Call Competitive Procurement

Barriers and Challenges:

- Hybrid CHP deployment is limited due to lack of understanding of configuration options, economics and resilience benefits

AMO MYPP Connection:

- MYPP Target 13.1 - Achieve a ten-fold cumulative increase in direct CHP technical support activities to potential commercial, institutional, and industrial end-users

Project Team and Roles:

- **NREL**: Team lead; user interface, API, and open source model development
- **Colorado School of Mines (CSM)**: CHP model validation and optimization efficiency
- **Clean Energy Group**: Stakeholder engagement and outreach

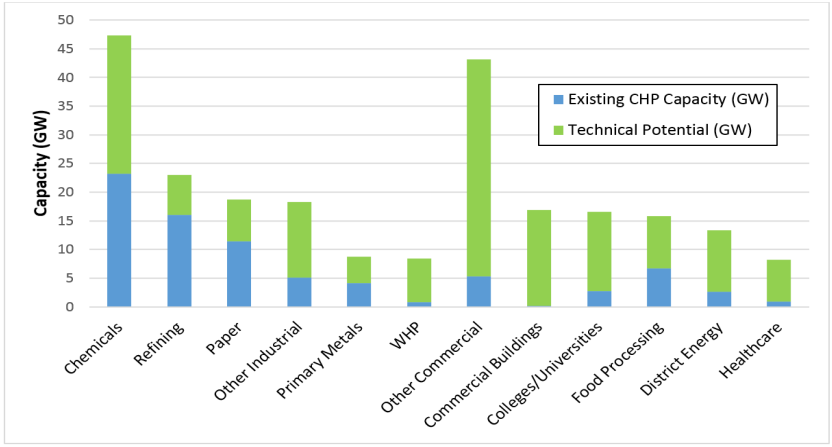
COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

NREL Transforming ENERGY

CleanEnergyGroup
Innovation in Finance, Technology & Policy

Project Objectives

- **Problem Statement**:
  - Hybrid CHP can reduce energy costs and emissions while providing more resilient electric power and thermal energy
  - Lack of understanding of technology options and benefits limits current deployment
  - There is a gap in the public space for a tool that integrates CHP with renewable technologies



U.S. DOE CHP Deployment Program, 2016.

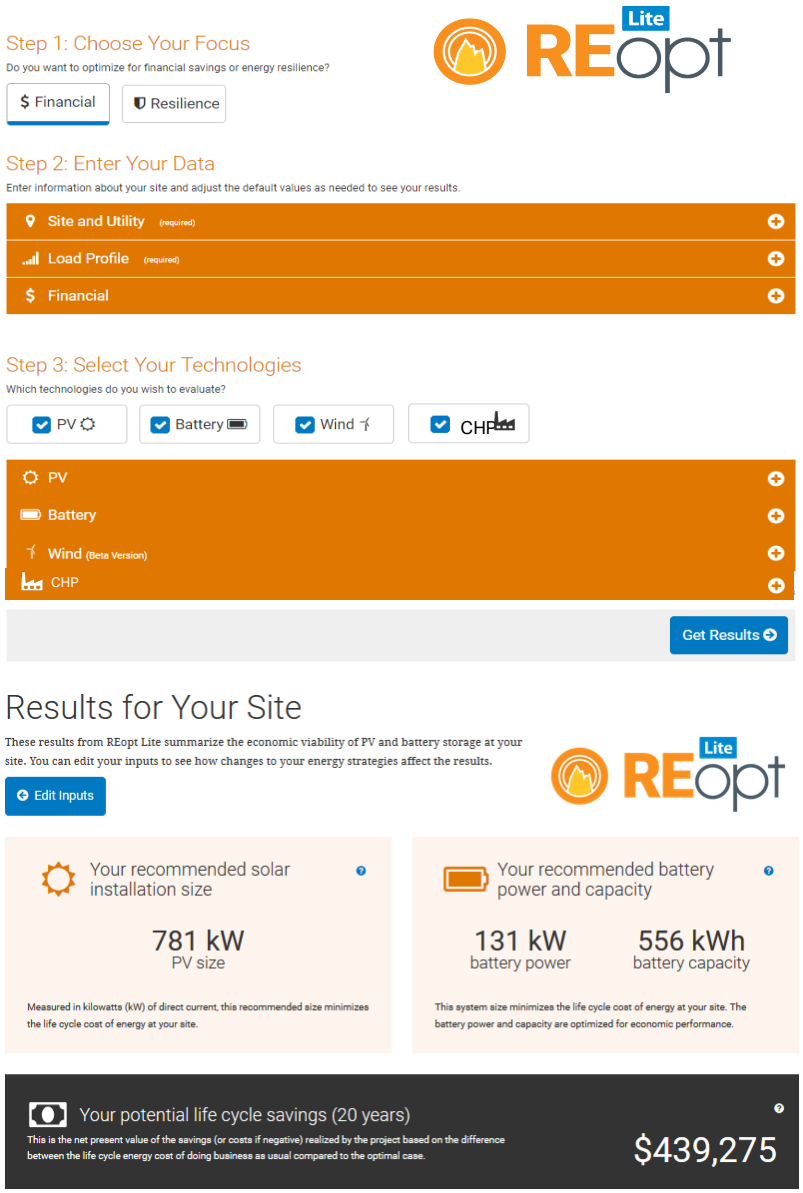
CHP Technical Potential

- **Project Objectives**:
  - Increase deployment of hybrid CHP by providing a free online decision tool to:
    - Assess hybrid CHP opportunities at a candidate site
    - Quantify economic and resilience benefits
  - Optimize system configuration, size, and dispatch for lowest energy cost
  - Educate customers and inform investment decisions
- **Support for AMO Goals:**
  - Hybrid CHP improves energy efficiency and reduces lifecycle energy of manufacturing sites
  - Tool catalyzes adoption of CHP to drive economic competitiveness and energy productivity
  - Tool provides online resources for site self-assessment of CHP potential and highlights opportunities for hybrid CHP-renewable systems (MYPP Target 13.1)

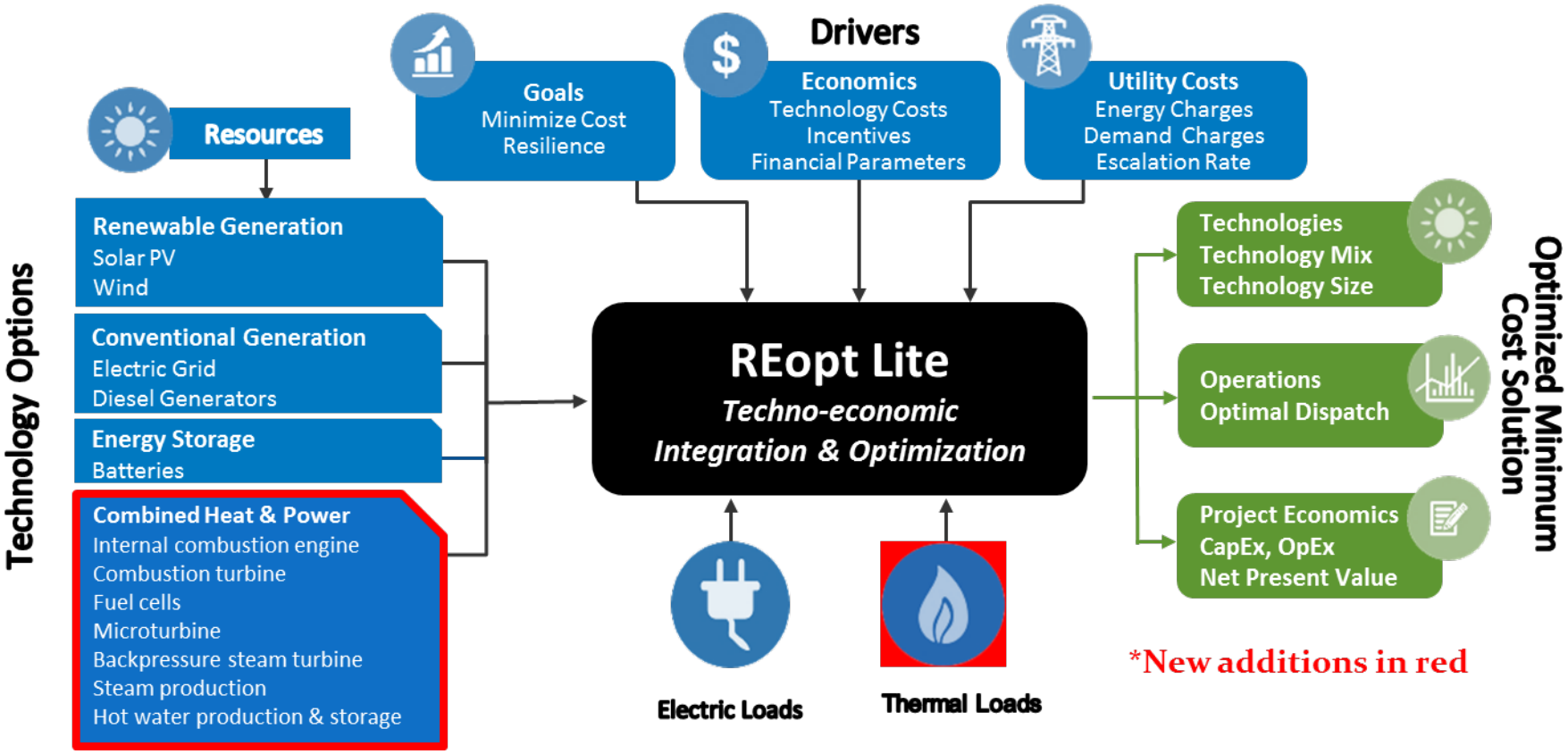
Hybrid CHP= Combined Heat and Power (CHP) with solar PV and battery storage

Technical Innovation

- Current Practice and Limitations:
  - Most current tools evaluate CHP alone
  - Non-expert tools make many simplifications, while expert tools are too complex for a broad range of users
- Proposed approach
  - Optimize integrated CHP-renewable energy systems to decrease energy costs and emissions and increase resilience
  - Provide complex, expert-level analysis in an easy-to-use tool with actionable results
- Innovations
  - Apply advanced techniques to optimize system design and dispatch
  - Make expert-level analysis widely accessible through web, API, and open-source options with pre-populated default datasets
- Impact
  - Identify opportunities for efficient, low-cost, resilient hybrid CHP systems



Technical Approach



Technical Approach

- Add CHP to REopt Lite mixed integer linear optimization model
- Optimize size and dispatch of hybrid CHP system to minimize lifecycle cost of energy
- Quantify economic and resilience benefits to guide users to cost-effective, resilient technologies
- Provide options for simple screening and more detailed analysis

Roles

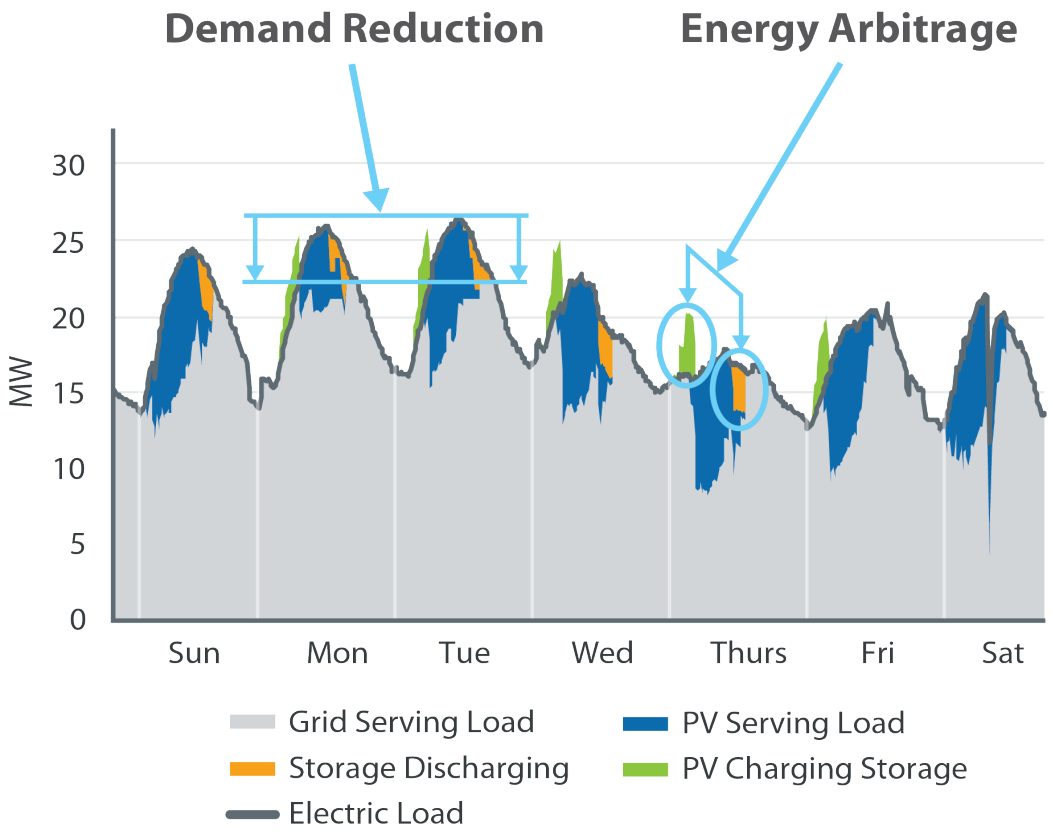
- NREL: User interface, API, and open-source model development
- CSM: Model validation and optimization speed up
- Clean Energy Group: Stakeholder engagement and outreach

Technical Approach, cont.

REopt Lite Optimizes Size and Dispatch of Integrated Systems

REopt Lite:

- Considers the integrated operation of multiple technologies
- Analyzes hourly data across the project lifecycle
- Evaluates the trade-off between capital costs, operating costs, and savings to find the most cost-effective mix
- Outputs include recommended technology types and sizes, economics, emissions, and resilience



Results and Accomplishments

- Conducting user interviews and developing design requirements
- Developing CHP model
  - Expanding existing model to incorporate thermal load, new prime movers, fuels, and thermal systems
  - Identifying datasets, costs, assumptions, and references
  - Identifying opportunities for efficiency improvements in code

	FY19	FY20	FY21
Q1 Progress Measure		Data sets and references identified	CHP model finalized and user testing and validation complete
Q2 Progress Measure	Kickoff meeting held	Preliminary CHP model integrated in REopt Lite	Beta REopt Lite CHP model for a single site deployed
Q3 Progress Measure	Data requirements developed	User interface design requirements developed	Model scaled to larger systems and validated
Q4 Progress Measure	Design requirements developed	Preliminary user interface developed	Final REopt Lite CHP model deployed and publicized
Go/No-Go	Design requirements developed	Preliminary CHP model completed	Final REopt Lite CHP model deployed

Transition (beyond DOE assistance)

- Model will be free, publicly available web tool hosted by NREL
- API and open source version ensures industry can easily adopt and expand
- Advisory group including DOE, CHP TAPs, EPA, and industry engaged to guide model development and provide stakeholder feedback
- Outreach includes conferences, webinars, user manual, case studies, papers

Who will use this tool?

Government (CHP TAPs, EPA partners, federal facilities, and national labs) evaluate hybrid CHP deployment opportunities.

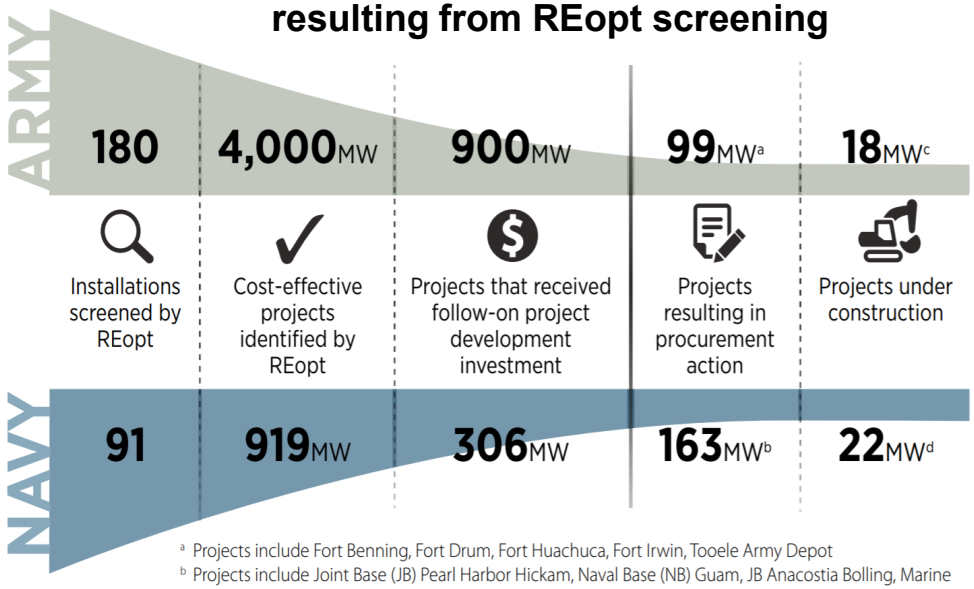
Developers identify the best market opportunities for hybrid CHP for targeted business development.

Building owners identify the best technologies for their site to reduce their energy costs.

Utilities understand how their rate tariffs incentivize (or disincentivize) hybrid CHP deployment.

Industry develops optimal control strategies for hybrid CHP to maximize the value they provide.

DOD renewable energy deployment resulting from REopt screening



[a] Projects include Fort Benning, Fort Drum, Fort Huachuca, Fort Irwin, Tooele Army Depot
[b] Projects include Joint Base (JB) Pearl Harbor Hickam, Naval Base (NB) Guam, JB Anacostia Bolling, Marine Corps Base (MCB) Lejeune, NB Ventura County, NWS Seal Beach, NWS Earle, Hawaii distributed PV
[c] Fort Huachuca
[d] MCB Lejeune and Hawaii distributed PV