itp RENEWABLES

OpenCEM for Samoa

Project plan for the delivery of a a Capacity Expansion Model for the Samoan grid

ENGINEERING | STRATEGY | ANALYTICS | CONSTRUCTION

Challenges for Pacific Island nations

- Ambitious electrification, renewable energy, and emission abatement targets
- Understanding the least-cost path to achieving these targets
- Climate change
- Electricity and diesel prices

Existing approaches to electricity planning in the Pacific

- Based on static reports from donor-based entities
- Don’t allow stakeholders to update or test new scenarios
- Based on analysis that lacks transparency
- May not be technology agnostic

An (ideal) Electricity Planning Process

1. Economic policy and outlook
2. Long term electricity sector planning
3. Individual project procurement, construction, commissioning, and connection
4. Power system operation and delivery to consumers

An (ideal) Electricity Planning Process

openCEM for Samoa is targeting a specific aspect of the planning process

1. Economic policy and outlook
2. **Long term electricity sector planning**
3. Individual project procurement, construction, commissioning, and connection
4. Power system operation and delivery to consumers

About openCEM

openCEM:

- was developed by ITP for Australia – funded by ARENA, NSW, Vic and SA
- is a freely available open-source grid integration model
- allows decision makers, energy system planners, regulators, and project developers to undertake scenario modelling
- is **designed** to be reconfigured to other electricity networks
- comes with updates, training and support
- is available at openCEM.org.au

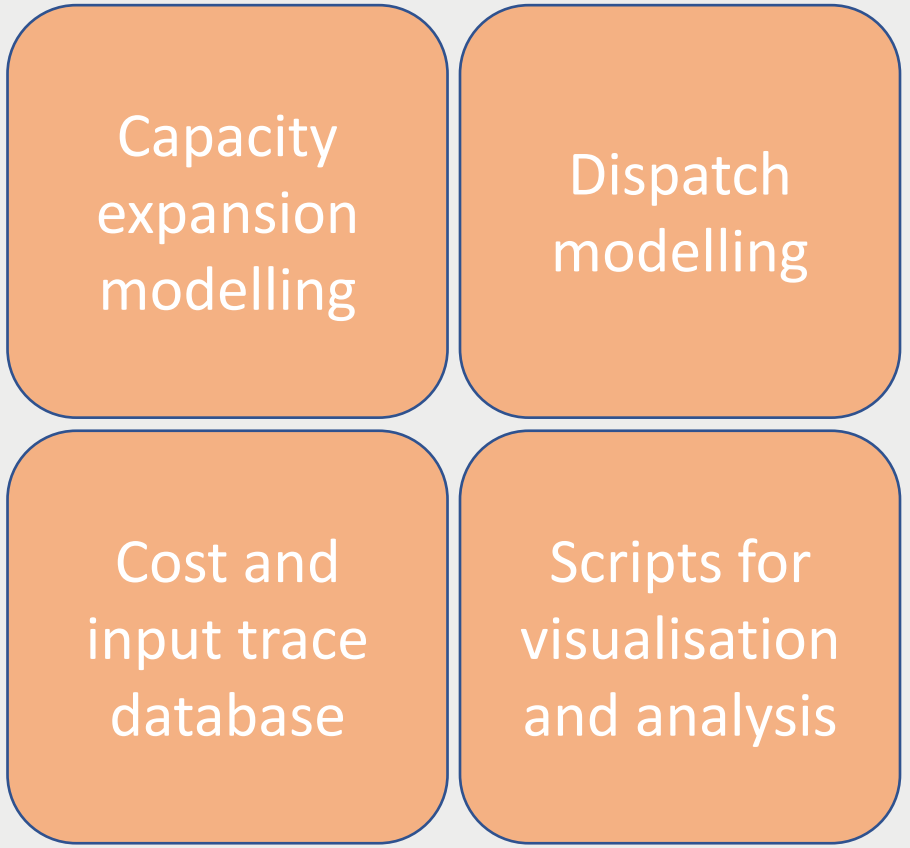
openCEM Overview

open-source Capacity Expansion Model

Computes least-cost electricity system expansion decisions

Custom generation, transmission, and storage

Tools for analysing and visualising results



A version of openCEM for Samoa

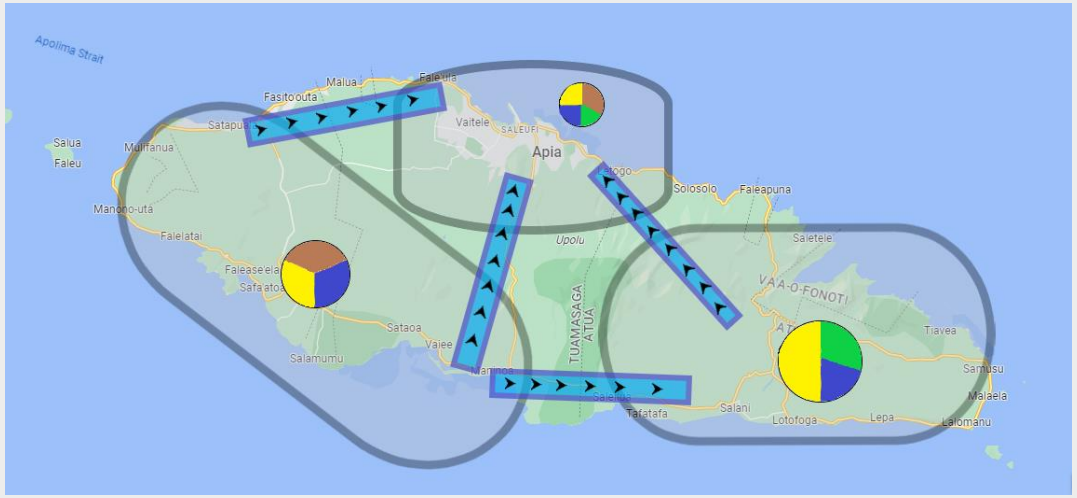
Tailored specifically to:

- Include country specific yearly cost projections for a diverse range of generation and storage technologies
- Include country specific geographic distribution of loads and transmission line options
- Explore the implications of changes in policy (including EV policy) and technology or fuel costs
- Test input assumptions and compare them to reference scenarios; and repeat and update modelling at any time, as new information arises

openCEM Architecture

Modelled region is divided into planning zones

For each zone, the model considers a configurable list of generation, storage, and hybrid technologies

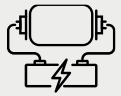


* **Example only,** not a final representation of openCEM for Samoa

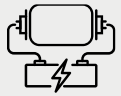
Generation, Storage, and Hybrid Technologies

Closed Cycle Gas Turbine (opt CCS)

Open Cycle Gas Turbine



Diesel Reciprocating Engines



Gas Reciprocating Engines

Hydro power (with reservoir output limits)

Large scale Solar PV (fixed and tracking)

Wind (high and low wind sites)

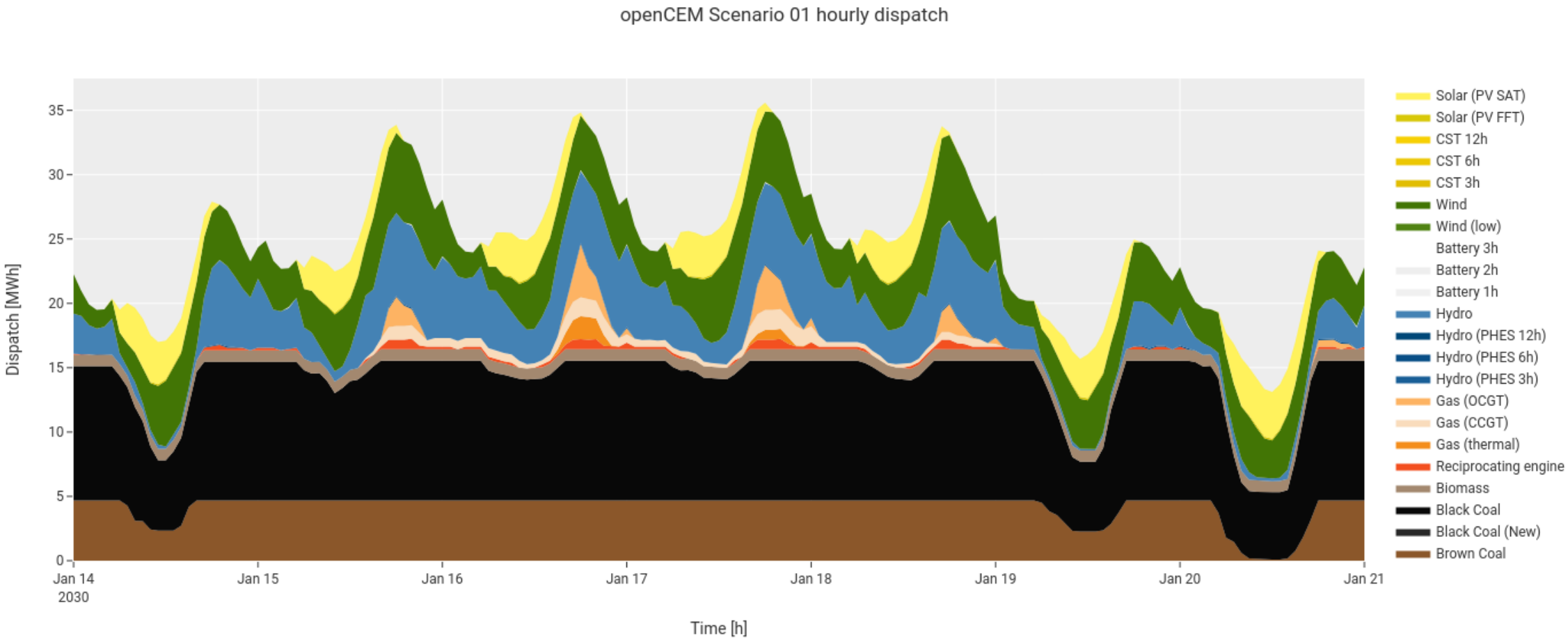
CST with storage (6, 12 or more hours of storage)

Pumped hydro energy storage (6, 12 or more hours of storage)

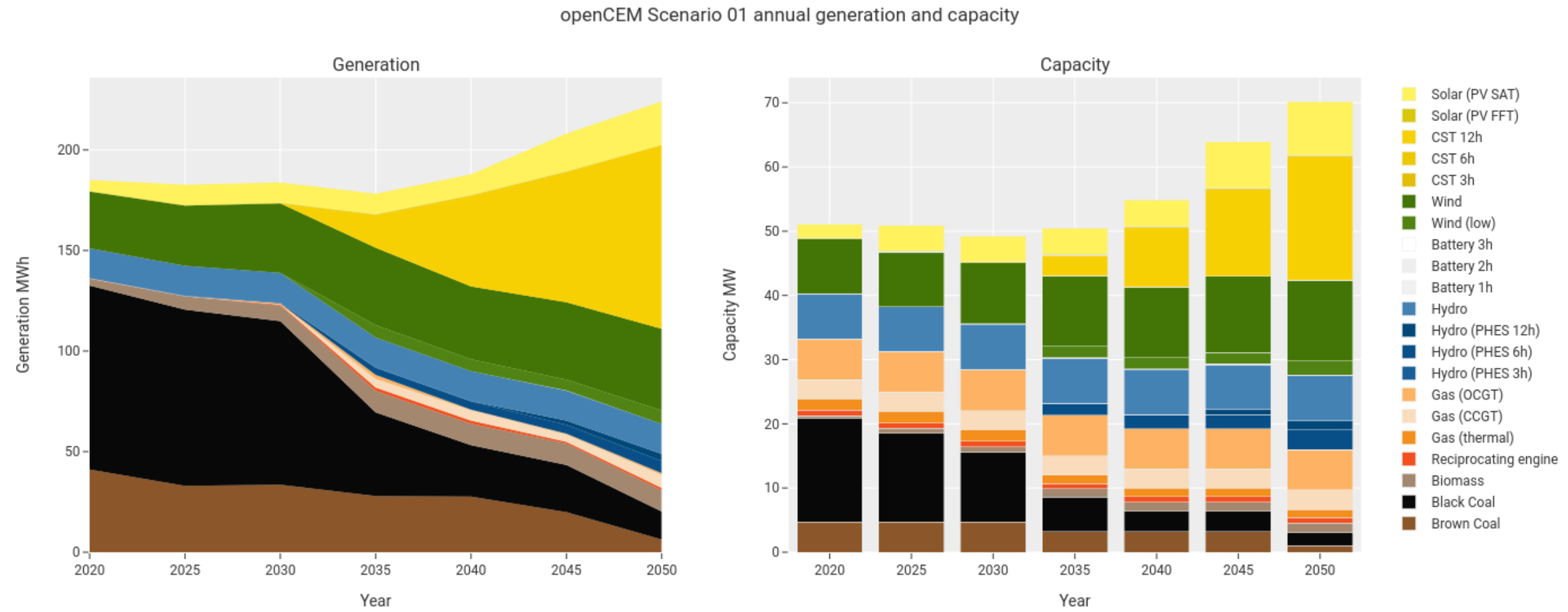
Large scale batteries (1, 2 and more hours of storage)

Biomass (with fuel availability limits)

Example Dispatch Results for Australia



Example Capacity outlook Results for Australia

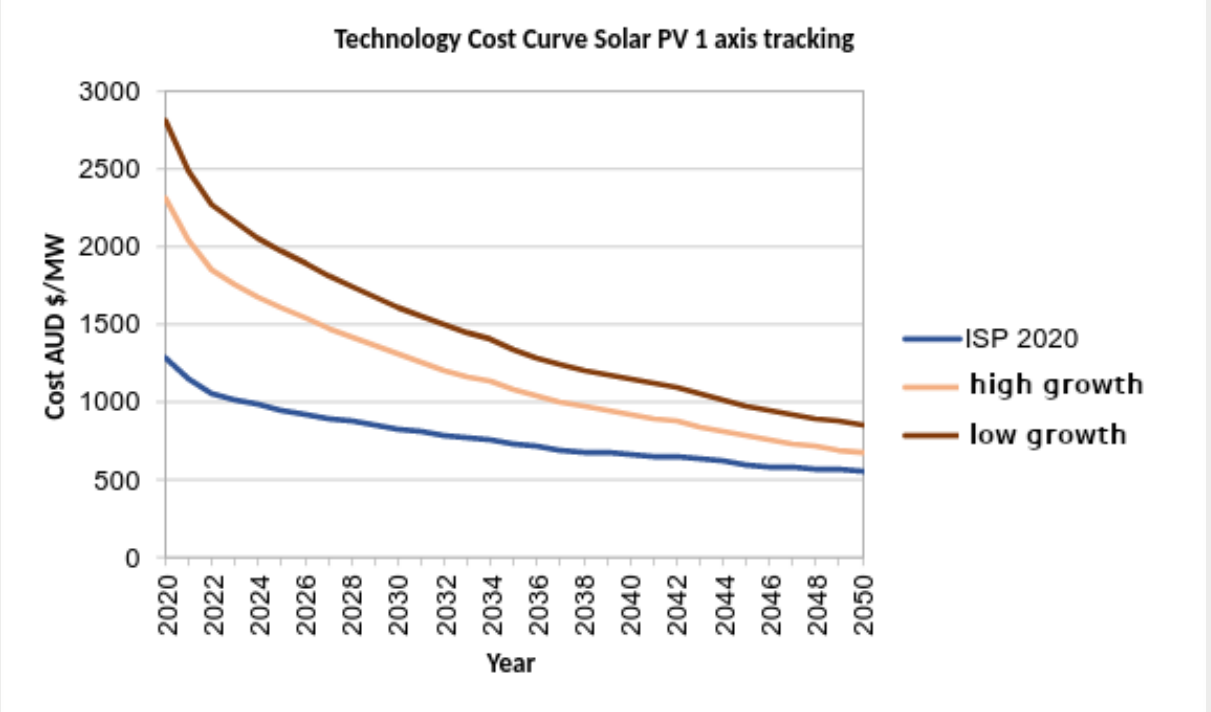


Custom country Technology and Fuel Costs

- Custom Country costs developed in consultation with utilities and in-country experts
- Build costs (in $/MW) are obtained for each technology, zone and year of the simulation
- Fuel costs (in $/GJ) are obtained for each technology in each region and each year of the simulation
- Fixed operating costs (in $/MW/year) and variable operating costs (in $/MWh) are obtained per technology
- Users can modify database costs to test assumptions (e.g. change in fuel prices)

Custom country Technology and Fuel Costs

- Country specific cost curves can be made based on existing and publicly available estimates
- Scenarios of low and high growth can account for technology cost improvements based on adoption and local learning



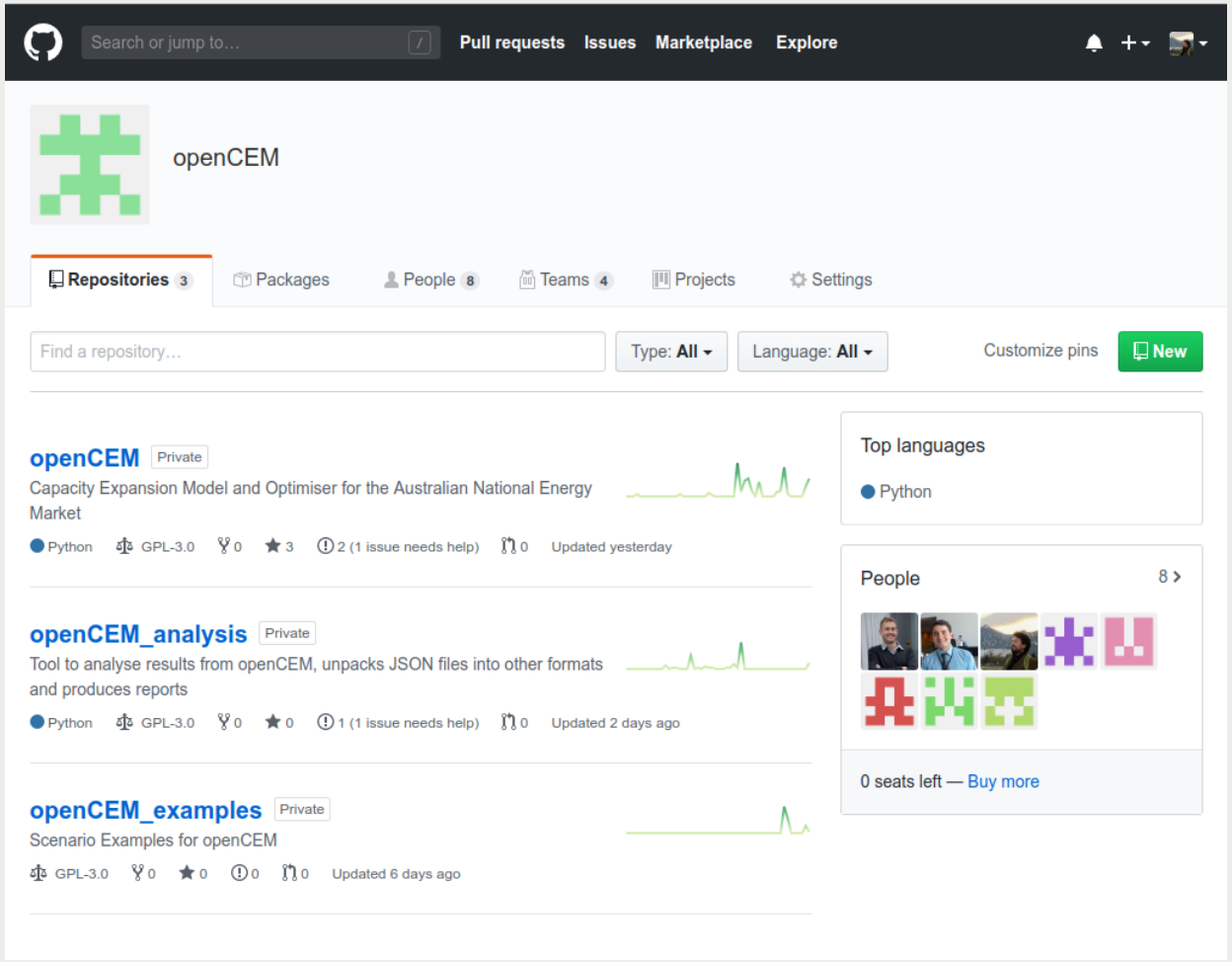
openCEM is open Source

openCEM is currently available at github.com/openCEMorg with examples and documentation

Model parameters are specified in an input file for each scenario configuration

Input database is web based so it is kept up to date and accessible to all

Current plan is for openCEM for Samoa to be released in a similar fashion



openCEM for Samoa | Work plan

- Represent Samoan grids in openCEM with:
  - Major load centres and potential areas for grid expansion.
  - Specific generation constraints, such as existing and new hydro dam yearly outputs, yearly availability of fuels, solar and wind build limits.
- Online database including country specific demand forecasts, resource traces, technology costs, and fuel costs.
- Scenario simulations and sensitivities for major projects, policy and emissions trajectories
- Refined in consultation with internal and external stakeholders

openCEM development phases

Implementation of openCEM for Samoa will involve 4 phases:

1. High level design of the model for Samoa
2. Develop openCEM dataset for Samoa
3. Redeploy the openCEM modelling tool for Samoa,
4. Provide training and capacity building

Each phase can be further divided into tasks as follows

Detailed project Plan openCEM for Samoa – Phase 1

ITP will guide a process to make decisions regarding the scope and resolution of the model in terms of geographic coverage, technologies, demand forecasting assumptions and in-country specific constraints.

Task	Objective	Methodology	Approximate timing
Partition into Planning zones	Select which areas of Samoa can be considered individual planning zones in terms of location of load centres and VRE sites	ITP Renewables in consultation with OOTR, EPC, and an external review	2 to 4 weeks
Identify power flow constraints between planning zones	Identify existing or potential flows of power between planning zones, including existing limits to model major transmission infrastructure across the countries	ITP Renewables in consultation with OOTR, EPC and an external review	2 to 4 weeks
Identify technology options and constraints	Identify technology constraints such as build limits for VRE zones based on land constraints or zoning requirements for generation and storage technology options	ITP Renewables in consultation with OOTR, EPC and an external review	2 to 4 weeks
Identify initial set of scenarios and policies	Determine policies and economic forecasts that have an influence in electricity demand (e.g. population growth, electric vehicles, large consumers)	ITP Renewables in consultation with OOTR, EPC and an external review	1 to 2 weeks
Total time for phase			2 to 4 months

Detailed project Plan openCEM for Samoa – Phase 2

In this phase, ITP will develop input data and assumptions for each planning zone in the openCEM for Samoa model and deploy them in a publicly available database.

Task	Objective	Methodology	Approximate timing
Produce demand forecasts	Produce detailed demand forecast time series for each planning zone, including separate components for underlying demand, behind the meter generation and storage, electric vehicle charging and other demand management programs.	ITP Renewables engineers and analysts will produce and review by OOTR, EPC and others	4 weeks
Produce cost curves	Produce cost projections for building, operating and fuel costs for identified technologies in each planning zone	ITP Renewables engineers and analysts will produce and review by OOTR, EPC and others	2 weeks
Produce resource traces and limits	Produce resource traces for VRE based on land availability constraints and technology specific density estimates	ITP Renewables engineers and analysts will produce and review by OOTR, EPC and others	1 week
Existing fleet	Produce list of existing, commissioning and announced projects, including their commissioning and planned retirement dates.	ITP Renewables engineers and analysts will produce and review by OOTR, EPC and others	1 week
Review and consultation	Share developed figures with stakeholders for review and comment	ITP Renewables engineers and analysts will produce and review by OOTR, EPC and others	2 weeks
Total time for phase			2 to 3 months

Detailed project Plan openCEM for Samoa – Phase 3

To redeploy openCEM for Samoa, the original openCEM codebase will need to be re-cast to match the newly developed database and incorporate specific in-country constraints identified in the high-level design of the model.

Task	Objective	Methodology	Approximate timing
Develop openCEM high level model for Samoa	Recast the model to the specific set of zones and dataset for Samoa, adjust and update model constraints for Samoa specific requirements. Create publicly available repositories and start model documentation.	ITP Renewables analysts and programmers will develop, review by others	2 weeks
Develop example scenarios for Samoa	Produce a list of example scenarios, including policies and associated demand and cost forecasts	ITP Renewables analysts and programmers will develop, review by others	1 week
Beta testing and review	Consult stakeholders to review, check and validate example scenario assumptions. Beta test use of standalone python model by in-country users	ITP Renewables analysts and programmers will develop, review by others	2 weeks
Develop openCEM frontend	Deploy a cloud-based version of the openCEM model (including commercial solver for faster results) and a re-cast front end to configure scenarios and compare results	ITP Renewables analysts and programmers will develop, review by others	3 weeks
Alpha testing	Consult stakeholders on the usability and versatility of the front-end, verify the functionality of the integrated pipeline	ITP Renewables analysts and programmers will develop, review by others	2 weeks
Total time for phase			2 to 3 months

Detailed project Plan openCEM for Samoa – Phase 4

The last stage will consist of delivering comprehensive training and capacity building for target users and stakeholders.

Task	Objective	Methodology	Approximate timing
Develop model training material	Develop a set of training material including documented assumptions and methodology for inputs, training on model methodology and usage, training on scenario analysis methodology	ITP Renewables engineers and analysts and review by OOTR, EPC and others	2 weeks
Develop frontend training material	Develop a set of training material for the use of the cloud-based frontend, including how to launch simulations, obtain and download results as well as assistance to develop further analysis based on model outputs	ITP Renewables engineers and analysts and review by OOTR, EPC and others	2 weeks
Training and capacity building	Deliver technical training sessions, aimed to build capacity across multiple stakeholder organisations (including OOTR and EPC) that support use of the model and the broader planning process	ITP Renewables engineers and analysts and review by OOTR, EPC and others	4 weeks
Total time for phase			1 to 2 months

ITP RENEWABLES
SUITE 1, LEVEL 1
19 MOORE ST TURNER ACT

POSTAL: PO BOX 6127, O'CONNOR,
ACT 2602, AUSTRALIA

E-MAIL: INFO@ITPAU.COM.AU
PHONE: +61 (0) 2 6257 3511

ITPAU.COM.AU

FOLLOW US: