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NATIONAL RENEWABLE ENERGY LABORATORY

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Introduction and Overview of SAM Open Source and SDK

Nicholas DiOrio

August 28, 2019

Virtual Conference 2019

Schedule for Wednesday, August 28, 2019

All times are in U.S. Mountain time.

10:00 - 10:30 am	Introduction and Overview of SAM Open Source and SDK	Nicholas DiOrio	National Renewable Energy Laboratory (NREL)
10:30 - 11:00	PySAM: An Improved Python Wrapper	Darice Guittet	NREL
11:00 - 11:20	Integrating SAM with SunDAT	Jaya Rajesekaran	FTC Solar
11:20 - 11:40	Integrating SAM with a Web Portal for PV Consumers in Saudi Arabia	Russ Jones	KA Care
11:40 - 12:00 pm	Integrating SAM for Rural Microgrid Load Modelling	Brian Somers	Standard Microgrid
12:00 - 12:20	Hydrogen Production From Variable Renewable Energies	Yassine Ennassiri	Moroccan Agency for Sustainable Energy (MASEN)
12:20 - 12:30	Wrap Up		

Motivation

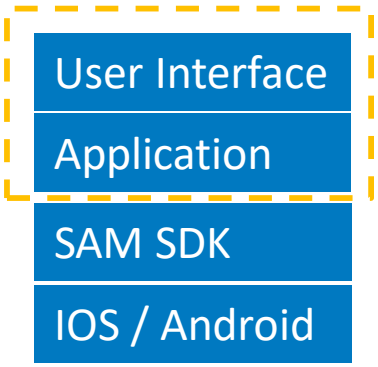
Open Source

- Inspect the underlying implementation of performance or financial models
- Add custom functionality or additional features for your projects
- Contribute and become part of the community.

```
class cm_pvwattsv5_base : public compute_module
{
protected:
    double dc_nameplate, dc_ac_ratio, ac_nameplate, inv_eff_percent;
    double loss_percent, tilt, azimuth, gamma;
    bool use_ar_glass;
    int module_type;
    int track_mode;
    double inoct;
    int shade_mode_1x;
    int array_type;
    double gcr;
```

Software Development Kit

- Wrap SAM in your project and access models of interest via public interfaces.
- Abstract out the things you don't want to reinvent so you can focus on what's important to you



Outline

- SAM Open Source
  - Repositories
  - Contributing
  - Licenses
- Software Development Kit (SDK)
  - Languages supported
  - Getting started

SAM Events 2019

- Introduction to PySAM, August 1, 2019
- Modeling Wind Systems in SAM, August 22, 2019
- **SAM Virtual Conference, August 28, 2019**
- Modeling Fuel Cells in SAM, September 19, 2019

Learn about upcoming events here:

https://sam.nrel.gov/events.html

System Advisor Model (SAM)

SAM is free software for modeling the performance and economics of renewable energy projects.

http://sam.nrel.gov
github.com/NREL/SAM

- Developed by NREL with funding from DOE
- Windows, OSX, and Linux
- One or two new versions per year
- Software Development Kit (SDK)
- Support

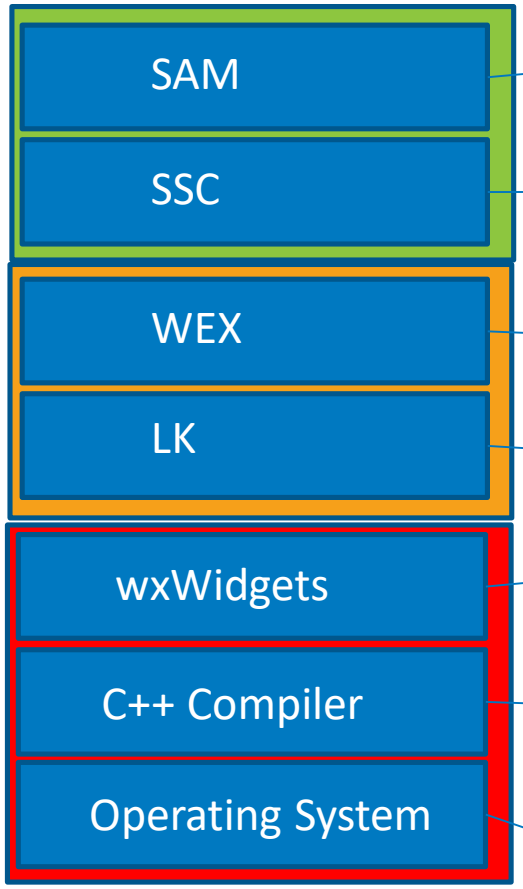
NREL actively maintains and releases new versions of SAM compiled from the open source repositories.

SAM Open Source Code Architecture

Core SAM code (C++11)

NREL libraries (C++11)

Development dependencies



Graphical User Interface.

Technology model libraries. Contains SAM SDK.

Custom widgets for SAM, contains DView project

Scripting support

wxWidgets 3.1.0, GUI framework

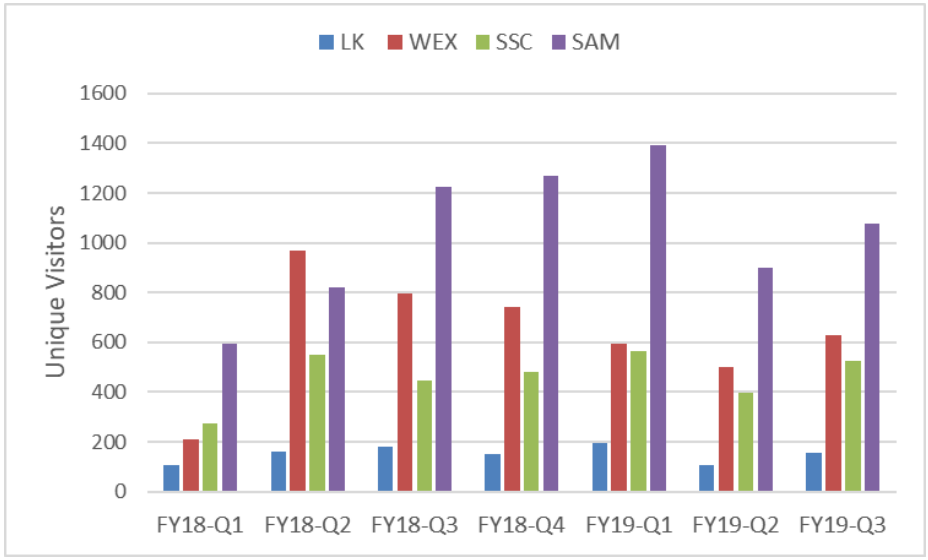
Visual Studio 2013, GCC 4.8.5 minimum, libc 2.17

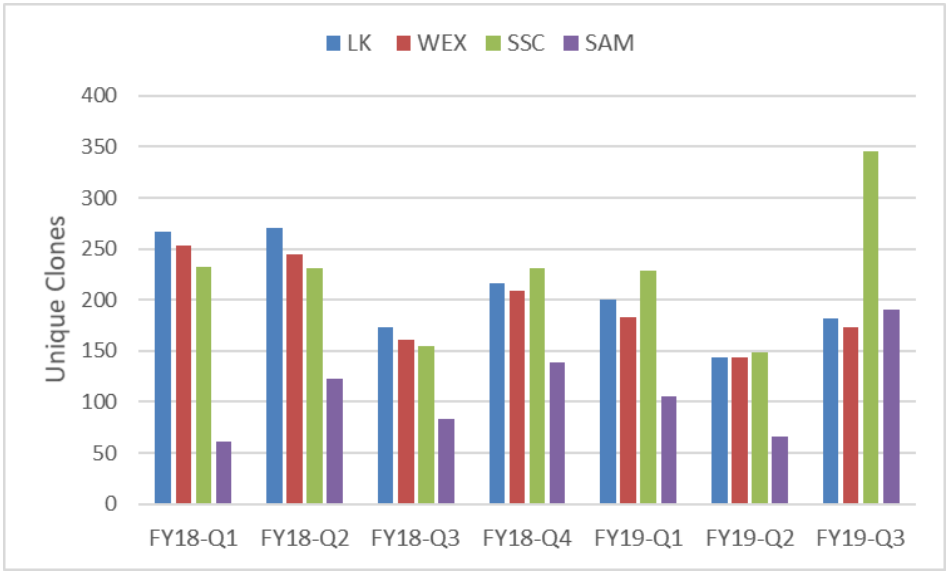
Windows, OSX, Linux (CentOS 7, Ubuntu 16.04, Fedora 25, Mint 18.2)

Code Locations

wxWidgets	https://www.wxwidgets.org/downloads/
LK	https://github.com/NREL/lk
WEX	https://github.com/NREL/wex
SSC	https://github.com/NREL/ssc
SAM	https://github.com/NREL/SAM

If you are new to Git and GitHub, please checkout: https://guides.github.com





LK, WEX, SSC, and SAM are now all licensed under BSD-3-clause

Accepting contributions

Contribution Policy

Janine edited this page 5 days ago · 7 revisions

SAM Contribution Policy

The SAM team welcomes your contribution to the project!

If you contribute code, you agree that your contribution may be incorporated into SAM and made available under the SAM license in compliance with standard GitHub terms of service.

In the effort to make SAM easy to contribute to, the contribution process is composed of three simple steps:

1. Fork the relevant SAM repositories.
2. Make your modifications. For large new features, we suggest that you email us before you start working so that we coordinate your contribution (see more info for large contributions below!).
3. Create a pull request.

Additional contribution help

Some additional details on what makes it more likely that your code will be readily accepted into the main development version of SAM.

- For large contributions
- Code quality and testing
- Documentation
- For further assistance

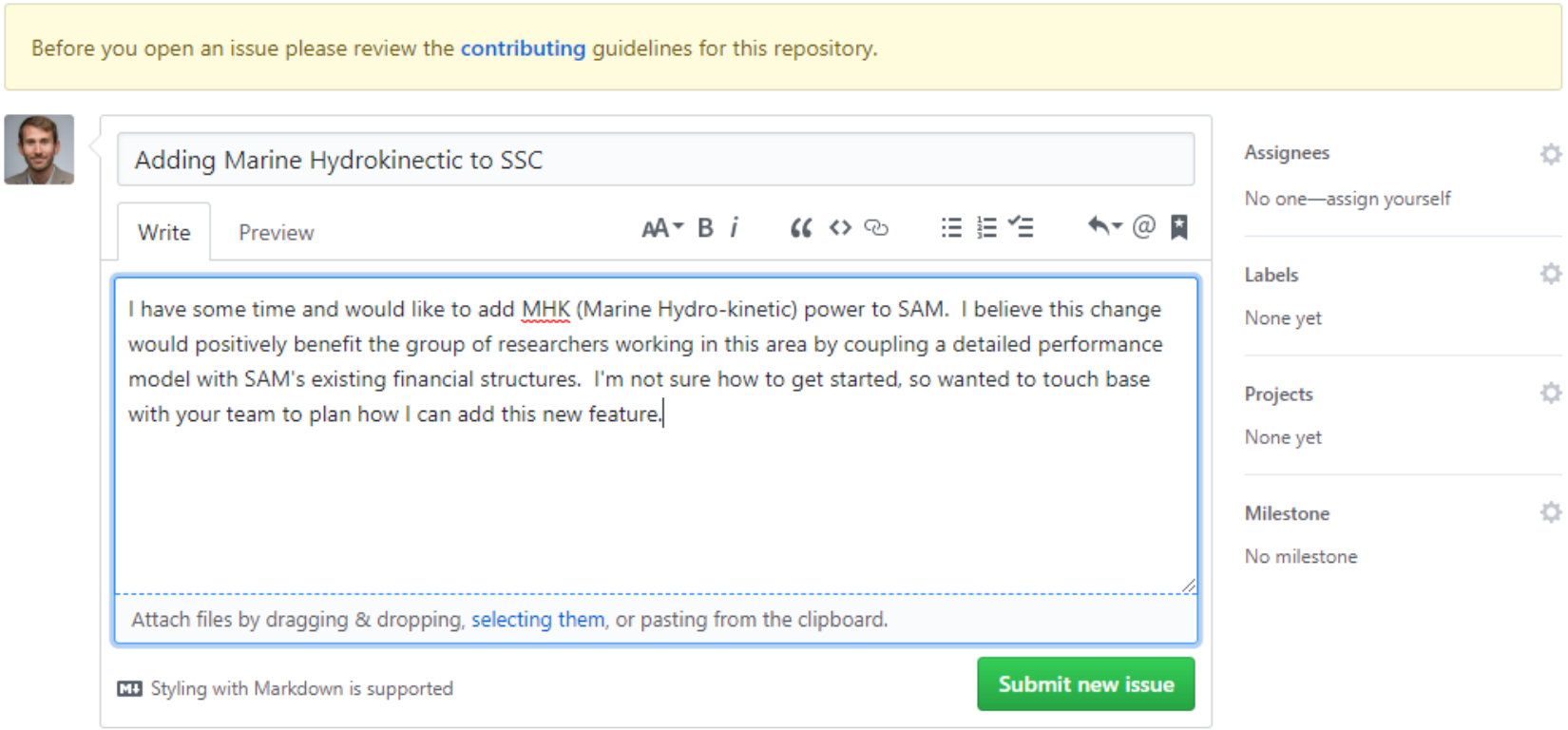
Best part of open-source is that anyone can contribute back to the code. Goal is to make this as easy as possible for everyone involved!

Code quality

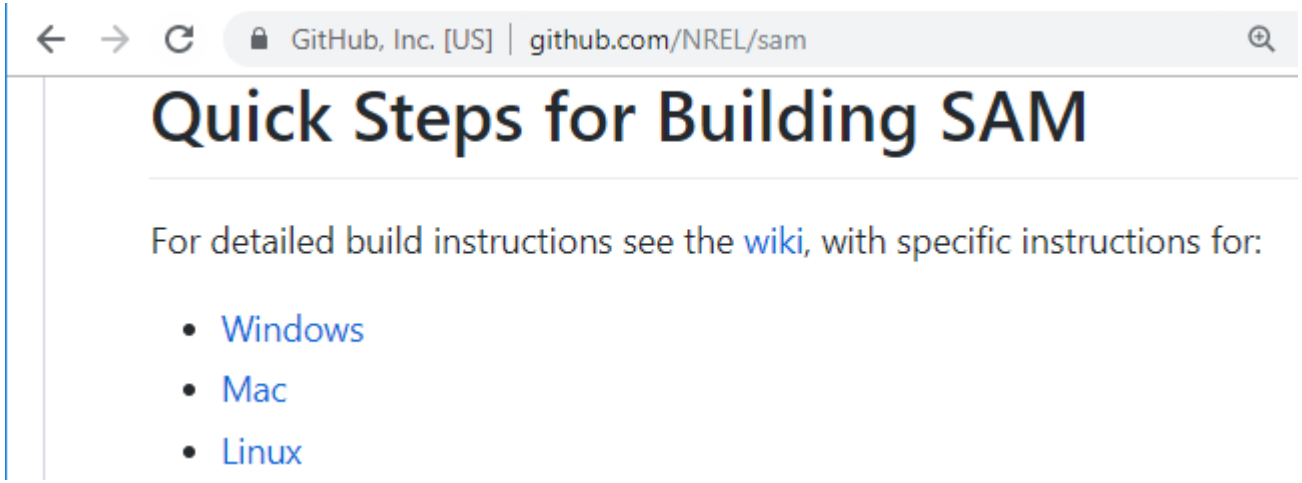
- **Testing**
  - We use GoogleTest
  - We'd like substantial new contributions to be included with tests.
  - Please fix any compiler warnings that you introduce.
- **Code Conventions**
  - Please try and broadly adhere to the same style of code in the area you will be working
- **Documentation**
  - For substantial changes, please ensure you comment your code and provide documentation about what it does

Issues tracking

If you discover a bug in the code, want to add a new feature, or have a question, use GitHub issues to tell us

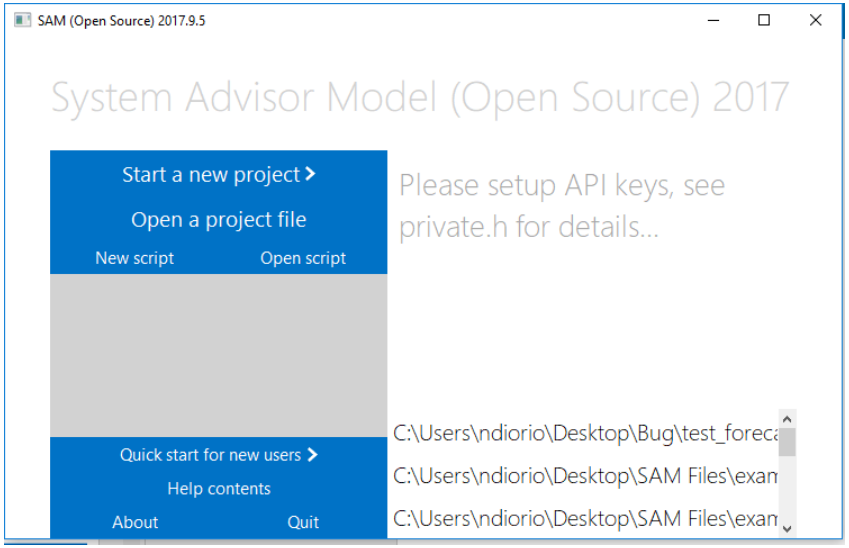


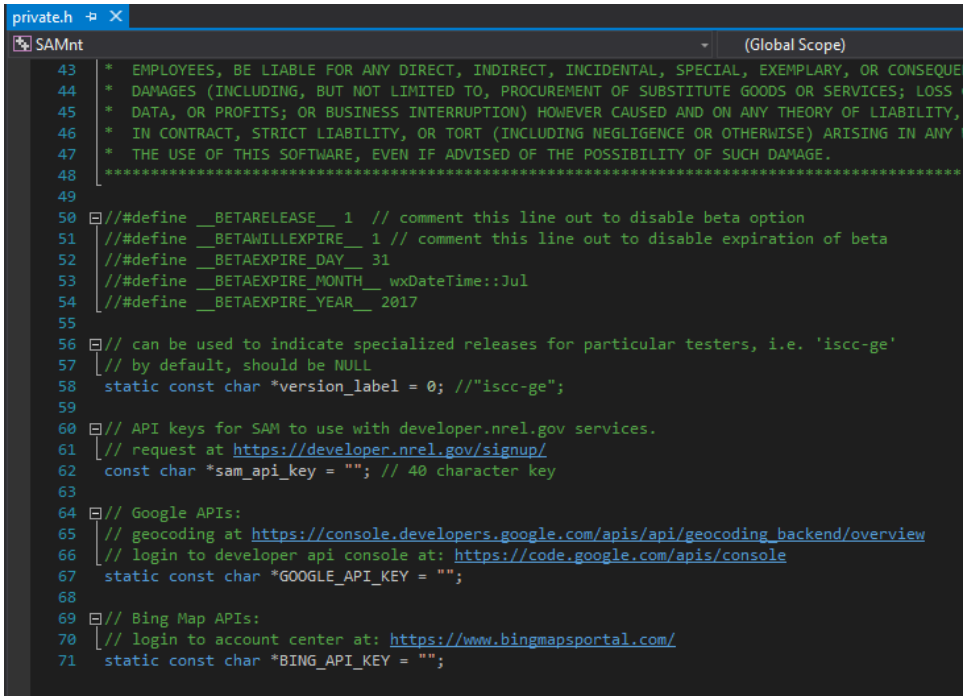
Building SAM open source



- Process outlined on GitHub for all platforms
- In the process of supporting CMake for all projects
- In the process of making LK, WEX, SSC submodules of the SAM repository for a more unified experience

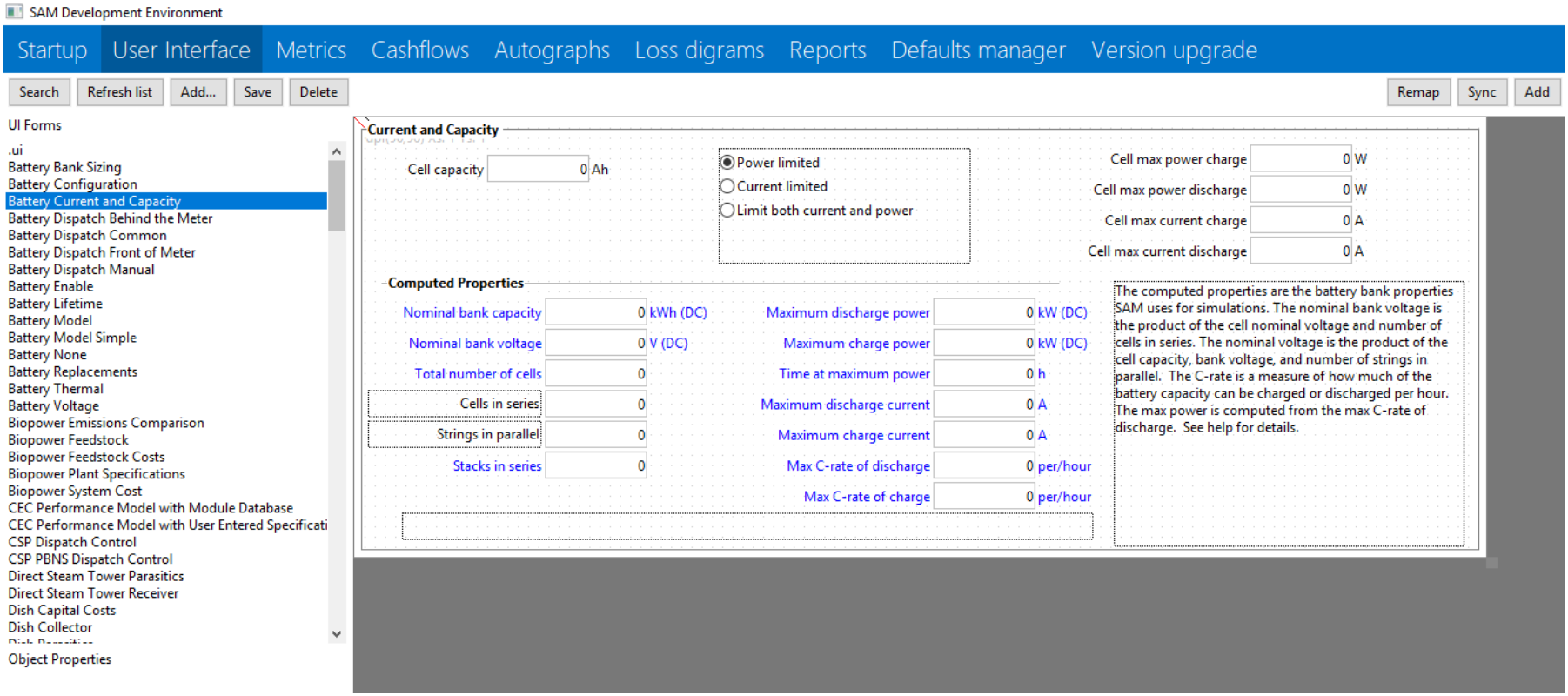
Setting up API Keys





- When you build SAM open-source, you'll need to get your own API keys setup
- Open the "private.h" file in the SAM project
- Go to the websites listed, and get the API keys. Paste them into the file between the empty quotes.
- Note, don't check in your API keys into the public repo!

Editing the user interface



- To edit user interface, open the open source SAM executable.
- Press Shift + F7
- Make changes, save.
- Click “Startup” tab and click restart (first make sure there are no open cases).
- You should see changes take effect

SAM Software Development Kit

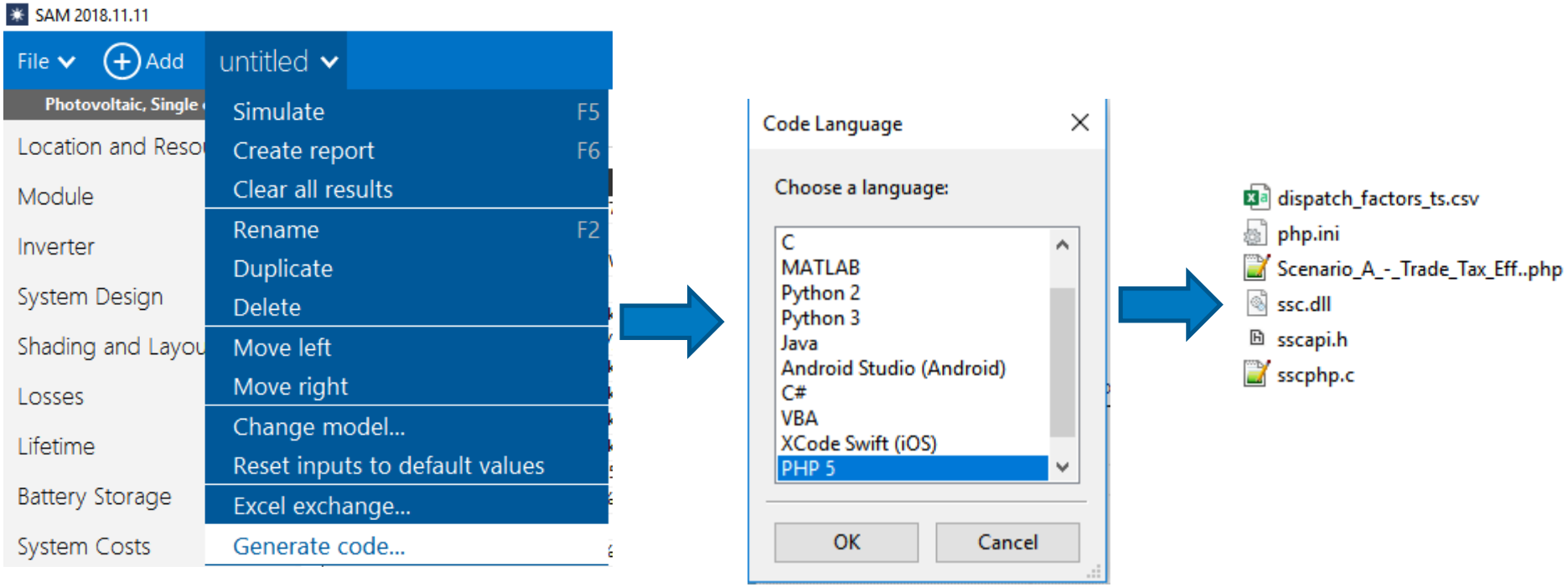
- The SAM Simulation Core (SSC) software development kit (SDK) is a collection of developer tools and documentation for creating renewable energy system models using the SSC library. The SDK allows you to create your own applications using the SSC library.

SDK supported language wrappers

Supported language wrappers

- LK for SDK tool
- C
- C#
- Python 2 and 3
- Java
- MATLAB
- PHP 5 and 7
- SAM inputs to JSON
- Android Studio
- XCode Swift for iOS

Generating inputs to SDK



Workflow

- Create a case in SAM desktop application that reflects the default model you want
- Click on the case drop down and select “Generate code”.
- Select the language wrapper of choice
- SAM will output the library (.dll/.so), as well as the relevant language code and inputs which you can then wrap in your code.

SDK overview

sscapi.h - Exposes available calls into SSC

Populate data

ssc_data_t : the underlying type holding data inputs and outputs
ssc_data_create() : return a *ssc_data_t*
*ssc_data_set_number(ssc_data_t, const_char * varname, double value)*
… other setters

Define and run model

ssc_module_t : an underlying SSC model (like PVWatts)
ssc_module_create("module") : return a *ssc_module_t*
ssc_module_exec(ssc_module_t module, ssc_data_t data): run the model with the given data

Extract data

*ssc_data_get_number(ssc_data_t, const_char * varname, double * value)*
.. Other getters

Each language wrapper is a set of functions that provide access to the underlying C-api using methods supported in the language

SDK Example using PHP5

```
$dat = sscphp_data_create();
sscphp_data_set_string( $dat, "solar_resource_file",
"C:/SAM/2018.11.11/solar_resource/blythe_ca_33.617773_-114.588261_psmv3_60_tmy.csv" );
sscphp_data_set_number( $dat, "system_capacity", 249 );
sscphp_data_set_number( $dat, "module_type", 0 );
sscphp_data_set_number( $dat, "dc_ac_ratio", 1.25 );
sscphp_data_set_number( $dat, "inv_eff", 96 );
sscphp_data_set_number( $dat, "losses", 14.075660705566406 );
sscphp_data_set_number( $dat, "array_type", 0 );
sscphp_data_set_number( $dat, "tilt", 15 );
sscphp_data_set_number( $dat, "azimuth", 180 );
sscphp_data_set_number( $dat, "gcr", 0.40000000596046448 );
sscphp_data_set_number( $dat, "adjust:constant", 0 );
$mod = sscphp_module_create("pvwattsv5");
api_call_to_pvwatts -> return 8760 generation profile
populate $dat, "gen" with pvwatts->ac*1000
if ( !sscphp_module_exec( $mod, $dat ) )
{
    $index = 0;
    while ($err = sscphp_module_log( $mod, $index++ ) )
    {
        echo "$err" . PHP_EOL;
    }
    exit;
}
sscphp_module_free( $mod );
```

Questions?