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# **pyiso Documentation**

*Release 0.3*

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## Introduction

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Pyiso provides Python client libraries for ISO and other power grid data sources. It powers the [WattTime Impact API](#), among other things.

### What's an ISO?

Electricity markets are operated by “balancing authorities,” which manage supply and demand for a given service area. The bigger balancing authorities, called Independent Services Operators and Regional Transmission Organizations (ISOs/RTOs, or simply ISOs), together cover about 2/3 of US electricity consumers.

ISOs are required to provide real-time data about electricity market operations, but choose to do so in a wide variety of unstandardized, inconvenient formats. Some smaller balancing authorities provide data too.

### What's included

Pyiso makes it easier to collect data from ISOs and other balancing authorities by providing a uniform Python interface to each data stream. See the [Usage](#) page for instructions on how to get started.

Specifically, here are the included balancing authorities and their respective data sources:

Note: Some balancing authorities offer data directly and through the EIA client.

The following BAs are available through the EIA client.

balancing authority abbrev.	balancing authority name/region	data source
AEC	PowerSouth Energy Cooperative	EIA
AECI	Associated Electric Cooperative, Inc.	EIA
AESO	Alberta Electric System Operator	EIA
AVA	Avista Corporation	EIA
AZPS	Arizona Public Service- EIA data	EIA
BANC	Bal Authority of Northern California	EIA
BCTC	British Columbia Transmission Corp	EIA
BPAT	Bonneville Power Admin- EIA data	EIA
CAISO	California ISO- EIA data	EIA
CFE	Comision Federal de Electricidad	EIA
CHPD	Pub Utility Dist 1 of Chelan County	EIA
CISO	California Independent System Operator	EIA
CPLD	Duke Energy Progress East	EIA

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balancing authority abbrev.	balancing authority name/region	data source
CPLW	Duke Energy Progress West	EIA
DEAA	DECA Arlington Valley (AZ)- EIA data	EIA
DOPD	PUD No. 1 of Douglas County	EIA
DUK	Duke Energy Carolinas	EIA
EEL	Electric Energy, Inc	EIA
EPE	El Paso Electric - EIA data	EIA
ERCO	Texas- EIA data	EIA
FMPP	Florida Municipal Power Pool	EIA
FPC	Duke Energy Florida	EIA
FPL	Florida Power and Light Co.	EIA
GCPD	PUD of Grant County, Washington	EIA
GRID	Gridforce Energy Management	EIA
GRIF	Griffith Energy (AZ) - EIA data	EIA
GRMA	Gila River Power	EIA
GVL	Gainesville Regional Utilities	EIA
GWA	NaturEner Power Watch	EIA
HGMA	Harquahala Gen Maricopa Az - EIA	EIA
HQT	Hydro-Quebec TransEnergie	EIA
HST	City of Homestead	EIA
IESO	Ontario IESO	EIA
IID	Imperial Irrigation District- EIA	EIA
IPCO	Idaho Power Company	EIA
ISNE	ISO New England - EIA data	EIA
JEA	JEA Jacksonville, Fl	EIA
LDWP	Los Angeles Dept of Water and Power	EIA
LGEE	Louisville Gas & Electric/KY Utilities	EIA
MHEB	Manitoba Hydro	EIA
MISO	Midcontinent ISO - EIA data	EIA
NBSO	New Brunswick System Operator	EIA
NEVP	Nevada Power - EIA data	EIA
NSB	New Smyrna Beach UC	EIA
NWMT	NorthWestern Corporation	EIA
NYIS	New York ISO - EIA data	EIA
OVEC	Ohio Valley Electric Corporation	EIA
PACE	PacifiCorp East	EIA
PACW	PacifiCorp West	EIA
PGE	Portland General Electric Co	EIA
PJM	Mid-Atlantic - EIA data	EIA
PNM	Public Service Co New Mexico- EIA	EIA
PSCO	Public Service Company of Colorado	EIA
PSEI	Puget Sound Energy	EIA
SC	South Carolina Public Service Auth	EIA
SCEG	South Carolina Electric and Gas	EIA
SCL	Seattle City Light	EIA
SEC	Seminole Electric Cooperative	EIA
SEPA	Southeastern Power Admin	EIA
SOCO	Southern Company Services	EIA
SPA	Southwestern Power Admin	EIA
SPC	Saskatchewan Power Corporation	EIA
SRP	Salt River Project (AZ) - EIA data	EIA
SWPP	Southwest Power Pool	EIA

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Table 1.1 – continued from previous page

balancing authority abbrev.	balancing authority name/region	data source
TAL	City of Tallahassee	EIA
TEC	Tampa Electric Company	EIA
TEPC	Tuscon Electric Power Co	EIA
TIDC	Turdock Irrigation District	EIA
TPWR	City of Tacoma DPU	EIA
TVA	Tennessee Valley Authority	EIA
WACM	Western Area Power Admin- Rocky Mtn	EIA
WALC	WAPA Desert Southwest (NV, AZ)-EIA	EIA
WAUW	Western Area Power Admin- Great Plains	EIA
WWA	NaturEner Wind Watch	EIA
YAD	Alcoa Power Generation- Yadkin	EIA

For European data, you also need to specify a “control area”. The available control areas are:

control area abbrev.	control area country/provider
AL	Albania
AT	Austria
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE(50HzT)	Germany (50 HzT)
DE(Amprion)	Germany (Amprion)
DE(TenneT GER)	Germany (TenneT)
DE(TransnetBW)	Germany (Transnet)
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MD	Moldavia
ME	Montenegro
MK	Macedonia
MT	Malta
NIE	UK (NIE)
NL	Netherlands
NO	Norway
National Grid	UK (National Grid)
PL	Poland
PL-CZ	Czech Republic/Poland
PT	Portugal

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Table 1.2 – continued from previous page

control area abbrev.	control area country/provider
RO	Romania
RS	Serbia
RU	Russia
RU-KGD	Russia (KGD)
SE	Sweden
SI	Slovenia
SK	Slovakia
TR	Turkey
UA	Ukraine
UA-WEPS	Ukraine (WEPS)

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## Installation

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### Install

Pyiso is available on [PyPI](#) and on [GitHub](#).

For users, the easiest way to get pyiso is with pip:

```
pip install pyiso
```

For developers, you can get the source from [GitHub](#) or [PyPI](#), then:

```
cd pyiso
python setup.py install
```

Pyiso depends on pandas so be prepared for a large install.

Windows Users: If you are unable to setup pyiso due to issues with installing or using numpy, a dependent package of pyiso, try installing a precompiled version of numpy found here: <http://www.lfd.uci.edu/~gohlke/pythonlibs/>

### Uninstall

To uninstall:

```
pip uninstall pyiso
```



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## Configuration

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### Accounts

ISONE and the EU each require a username and password to collect data. You can register for an ISONE account here (<http://www.iso-ne.com/participate/applications-status-changes/access-software-systems#data-feeds>) and an EU ENTSOe account here (<https://transparency.entsoe.eu/>).

Then, set your usernames and passwords as environment variables:

```
export ISONE_USERNAME=myusername1 export ISONE_PASSWORD=mysecret1 export
ENTSOe_USERNAME=myusername2 export ENTSOe_PASSWORD=myspassword2
```

The EIA API requires an API key. You can apply for a key here (<https://www.eia.gov/opendata/register.cfm>). To use the key, set an environment variable as follows:

```
export EIA_KEY=my-eia-api-key
```

All other ISOs allow unauthenticated users to collect data, so no other credentials are needed.

### Logging and debug

By default, logging occurs at the INFO level. If you want to change this, you can set the *LOG\_LEVEL* environment variable to the integer associated with the desired log level. For instance, ERROR is 40 and DEBUG is 10.

You can also turn on DEBUG level logging by setting the *DEBUG* environment variable to a truthy value. This setting will additionally enable caching during testing, which will significantly speed up the test suite.



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## Usage

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There are two main ways to use `pyiso`: via the client objects, or via celery tasks. The client approach is preferred for scripted data analysis. The task approach enables asynchronous or periodic data collection and is in use at the [WattTime Impact API](#).

### Clients

First, create a client using the `client_factory(ba_name)` function. `ba_name` should be taken from this list of abbreviated names for available balancing authorities listed on the [Introduction](#) page. For example:

```
>>> from pyiso import client_factory
>>> isone = client_factory('ISONE')
```

Requests made to external data sources will automatically time out after 20 seconds. To change this value, add a keyword argument in the constructor:

```
>>> isone = client_factory('ISONE', timeout_seconds=60)
```

Each client returned by `client_factory` is derived from `BaseClient` and provides one or more of the following methods (see also [Options](#)):

`BaseClient.get_generation` (*latest=False*, *yesterday=False*, *start\_at=False*, *end\_at=False*, *\*\*kwargs*)

Scrape and parse generation fuel mix data.

#### Parameters

- **latest** (*bool*) – If True, only get the generation mix at the one most recent available time point. Available for all regions.
- **yesterday** (*bool*) – If True, get the generation mix for every time point yesterday. Not available for all regions.
- **start\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be greater than or equal to this value. If using, must provide both `start_at` and `end_at` parameters. Not available for all regions.
- **end\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be less than or equal to this value. If using, must provide both `start_at` and `end_at` parameters. Not available for all regions.

**Returns** List of dicts, each with keys [ba\_name, timestamp, freq, market, fuel\_name, gen\_MW]. Timestamps are in UTC.

**Return type** list

BaseClient.**get\_load** (latest=False, yesterday=False, start\_at=False, end\_at=False, \*\*kwargs)  
Scrape and parse load data.

**Parameters**

- **latest** (*bool*) – If True, only get the load at the one most recent available time point. Available for all regions.
- **yesterday** (*bool*) – If True, get the load for every time point yesterday. Not available for all regions.
- **start\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be greater than or equal to this value. If using, must provide both start\_at and end\_at parameters. Not available for all regions.
- **end\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be less than or equal to this value. If using, must provide both start\_at and end\_at parameters. Not available for all regions.

**Returns** List of dicts, each with keys [ba\_name, timestamp, freq, market, load\_MW]. Timestamps are in UTC.

**Return type** list

BaseClient.**get\_trade** (latest=False, yesterday=False, start\_at=False, end\_at=False, \*\*kwargs)  
Scrape and parse import/export data. Value is net export (export - import), can be positive or negative.

**Parameters**

- **latest** (*bool*) – If True, only get the trade at the one most recent available time point. Available for all regions.
- **yesterday** (*bool*) – If True, get the trade for every time point yesterday. Not available for all regions.
- **start\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be greater than or equal to this value. If using, must provide both start\_at and end\_at parameters. Not available for all regions.
- **end\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be less than or equal to this value. If using, must provide both start\_at and end\_at parameters. Not available for all regions.

**Returns** List of dicts, each with keys [ba\_name, timestamp, freq, market, net\_exp\_MW]. Timestamps are in UTC.

**Return type** list

BaseClient.**get\_lmp** (latest=False, yesterday=False, start\_at=False, end\_at=False, \*\*kwargs)  
Scrape and parse location marginal price data. To request a specific LMP node, include kwarg node\_id.

**Parameters**

- **latest** (*bool*) – If True, only get LMP at the one most recent available time point. Available for all regions.



- **yesterday** (*bool*) – If True, get LMP for every time point yesterday. Not available for all regions.
- **start\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be greater than or equal to this value. If using, must provide both `start_at` and `end_at` parameters. Not available for all regions.
- **end\_at** (*datetime*) – If the datetime is naive, it is assumed to be in the timezone of the Balancing Authority. The timestamp of all returned data points will be less than or equal to this value. If using, must provide both `start_at` and `end_at` parameters. Not available for all regions.

**Returns** List of dicts, each with keys [`ba_name`, `timestamp`, `freq`, `market`, `lmp`, `lmp_type`]. Timestamps are in UTC.

#### Return type list

The lists returned by clients are conveniently structured for import into other data structures like `pandas.DataFrame`:

```
>>> import pandas as pd
>>> data = isone.get_generation(latest=True)
>>> df = pd.DataFrame(data)
>>> print df
  ba_name freq fuel_name  gen_MW market  timestamp
0  ISONE  n/a    coal    1170.0  RT5M  2014-03-29 20:40:27+00:00
1  ISONE  n/a    hydro    813.8  RT5M  2014-03-29 20:40:27+00:00
2  ISONE  n/a   natgas   4815.7  RT5M  2014-03-29 20:40:27+00:00
3  ISONE  n/a   nuclear  4618.8  RT5M  2014-03-29 20:40:27+00:00
4  ISONE  n/a   biogas    29.5  RT5M  2014-03-29 20:40:27+00:00
5  ISONE  n/a   refuse    428.6  RT5M  2014-03-29 20:40:27+00:00
6  ISONE  n/a    wind     85.8  RT5M  2014-03-29 20:40:27+00:00
7  ISONE  n/a   biomass   434.3  RT5M  2014-03-29 20:40:27+00:00
```

Happy data analysis!

## Tasks

If you have a `celery` environment set up, you can use the tasks provided in the `pyiso.tasks` module. There is one task for each of the client's `get_*` methods that implements a thin wrapper around that method. The call signatures match those of the corresponding client methods, except that the `ba_name` is a required first argument. For example, to get the latest ISONE generation mix data every 10 minutes, add this to your `celerybeat` schedule:

```
CELERYBEAT_SCHEDULE = {
    'get-isone-genmix-latest' : {
        'task': 'pyiso.tasks.get_generation',
        'schedule': crontab(minute='*/10'),
        'args': ['ISONE'],
        'kwargs': {'latest': True},
    }
}
```

In practice, you will want to chain these tasks with something that captures and processes their output.



## Options

Not all date range options are available for all methods in all regions. Here's what's available now:

method	latest	start_at and end_at pair	yesterday	forecast ok
BPA.get_generation	yes	yes	no	no
BPA.get_load	yes	yes	no	no
CAISO.get_generation	yes	yes	yes	yes
CAISO.get_load	yes	yes	yes	yes
CAISO.get_trade	yes	yes	yes	yes
CAISO.get_lmp	yes	yes	yes	yes
EIA.get_generation	yes	yes	yes	no
EIA.get_load	yes	yes	yes	yes
EIA.get_trade	yes	yes	yes	no
ERCOT.get_generation	yes	no	no	no
ERCOT.get_lmp	yes	yes	no	yes
ERCOT.get_load	yes	yes	no	yes
EU.get_load	yes	yes	no	yes
ISONE.get_generation	yes	yes	no	no
ISONE.get_lmp	yes	yes	yes	yes
ISONE.get_load	yes	yes	no	yes
MISO.get_generation	yes	yes	no	yes
MISO.get_load	yes	yes	no	yes
MISO.get_trade	no	yes	no	yes
MISO.get_lmp	yes	yes	no	yes
NVEnergy.get_load	yes	yes	no	yes
NYISO.get_generation	yes	yes	no	no
NYISO.get_load	yes	yes	no	yes
NYISO.get_lmp	yes	yes	no	yes
NYISO.get_trade	yes	yes	no	no
PJM.get_generation	yes	no	no	no
PJM.get_load	yes	yes	no	yes
PJM.get_trade	yes	no	no	no
PJM.get_lmp	yes	yes	no	no
SVERI.get_generation	yes	yes	no	no
SVERI.get_load	yes	yes	no	no



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## Contributing

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Right now, `pyiso` only has interfaces for collecting a small subset of the interesting electricity data that the ISOs provide. You can help by adding more! Please create an issue on [github](#) if you have questions about any of this.

### For developers

When you're ready to get started coding:

- fork the [repo](#)
- install in development mode: `python setup.py develop`
- run the tests: `python setup.py test` (or `python setup.py test -s tests.test_some_file.TestSomeClass.test_some_method` to run a specific subset of the tests)
- add tests to the `tests` directory and code to the `pyiso` directory, following the conventions that you see in the existing code
- add docs to the `docs/source` directory
- add a note to the changelog in `README.md`
- send a pull request
- sign the CLA at <https://www.clahub.com/agreements/WattTime/pyiso> (see below)

### For data users

Found a bug, or know of a data source that you think `pyiso` should include? Please add an issue to [github](#). Ideas of new balancing authorities (anywhere in the world) and of new data streams from ISOs we already support are both very welcome.

### For project admins

Before making a release, check that these are true in the master branch of the GitHub repo:

- the changelog in `README.md` includes all changes since the last release
- test coverage is good and the tests pass locally and on Travis

- changes are reflected in the docs in *docs/source*
- the version number is upgraded in *pyiso/\_\_init\_\_.py*

To make a release, run these commands (replacing 0.x.y with the correct version number):

```
git checkout master
git pull origin master
git tag v0.x.y
git push origin master --tags
python setup.py sdist upload
```

Releasing via twine:

```
python setup.py sdist
twine upload dist/pyiso-VERSION.tar.gz
```

## Legal things

Because we use pyiso as the base for our other software products, we ask that contributors sign the following Contributor License Agreement. If you have any questions, or concerns, please drop us a line on Github.

You and WattTime, Corp, a california non-profit corporation, hereby accept and agree to the following terms and conditions:

Your “Contributions” means all of your past, present and future contributions of object code, source code and documentation to pyiso however submitted to pyiso, excluding any submissions that are conspicuously marked or otherwise designated in writing by You as “Not a Contribution.”

You hereby grant to the WattTime, Corp a non-exclusive, irrevocable, worldwide, no-charge, transferable copyright license to use, execute, prepare derivative works of, and distribute (internally and externally, in object code and, if included in your Contributions, source code form) your Contributions. Except for the rights granted to the WattTime, Corp in this paragraph, You reserve all right, title and interest in and to your Contributions.

You represent that you are legally entitled to grant the above license. If your employer(s) have rights to intellectual property that you create, you represent that you have received permission to make the Contributions on behalf of that employer, or that your employer has waived such rights for your Contributions to pyiso.

You represent that, except as disclosed in your Contribution submission(s), each of your Contributions is your original creation. You represent that your Contribution submissions(s) included complete details of any license or other restriction (including, but not limited to, related patents and trademarks) associated with any part of your Contributions(including a copy of any applicable license agreement). You agree to notify WattTime, Corp of any facts or circumstances of which you become aware that would make Your representations in the Agreement inaccurate in any respect.

You are not expected to provide support for your Contributions, except to the extent you desire to provide support. You may provide support for free, for a fee, or not at all. Your Contributions are provided as-is, with all faults, defects and errors, and without any warranty of any kind (either express or implied) including, without limitation, any implied warranty of merchantability and fitness for a particular purpose and any warranty of non-infringement.

To get started, <a href="https://www.clahub.com/agreements/WattTime/pyiso">sign the Contributor License Agreement</a>.

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### Supporting

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Pyiso is an open source project maintained by [WattTime](#), a nonprofit that develops software standards to reduce power grid pollution and enable new kinds of clean energy choices.

We've spent more than 1000 developer-hours building pyiso, keeping it up-to-date with evolving data sources, and adding features requested by the community. As the foundation of our internal data pipeline, it makes our work easier every day. And we've made it free and open source because we want to make open energy data access a bit easier for other researchers, engineers, and citizens too!

Want to chip in and support pyiso? You or your company can make a tax-deductible donation to WattTime [here](#). Every dollar helps us help you! We also have corporate sponsorship opportunities available; [get in touch](#) if you're interested.

Another great way to support pyiso is to send us a quick [thank-you note](#). Your testimonials help us raise money from other folks, so it really does make a difference. Thanks bunches!





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## Indices and tables

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- *genindex*
- *modindex*
- *search*