Membership Overview

This deck is available in your LFX Organizational Dashboard

LF ENERGY

Antitrust Policy Notice

Linux Foundation meetings involve participation by industry competitors, and it is the intention of the Linux Foundation to conduct all of its activities in accordance with applicable antitrust and competition laws. It is therefore extremely important that attendees adhere to meeting agendas, and be aware of, and not participate in, any activities that are prohibited under applicable US state, federal or foreign antitrust and competition laws.

Examples of types of actions that are prohibited at Linux Foundation meetings and in connection with Linux Foundation activities are described in the Linux Foundation Antitrust Policy available at linuxfoundation.org/antitrust-policy. If you have questions about these matters, please contact your company counsel, or if you are a member of the Linux Foundation, feel free to contact Andrew Updegrove of the firm of Gesmer Updegrove LLP, which provides legal counsel to the Linux Foundation.

LF ENERGY

Antitrust Policy Notice

The Linux Foundation is a pre-competitive platform that enables cooperation and leveraged development.

LF ENERGY

Mission/Vision

The Linux Foundation's mission is to support the world's most important shared technology collaborations.

LF Energy's mission is to create a technology ecosystem to support rapid decarbonization that benefits the environment, enables economic prosperity, and leads to social well-being for future generations.

Reference: Climate Tech Review overview of LF Energy for the Climate Tech 100

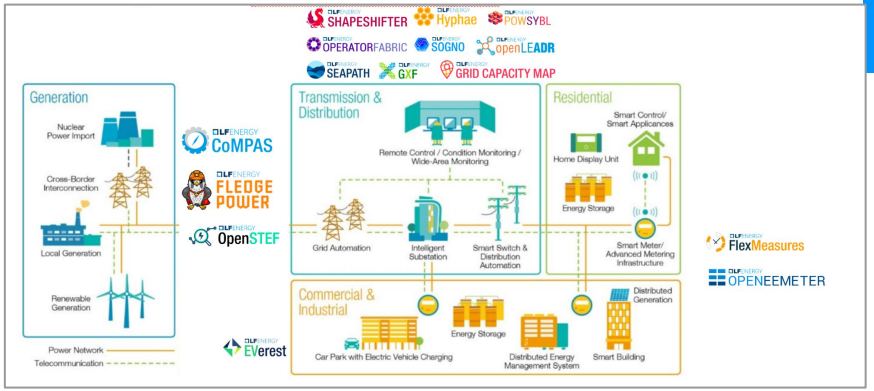
Linux Foundation Energy is a vendor-neutral, non-profit organization that brings together energy producers, utilities, end users, academia, government and the technology industry to collaboratively develop technology solutions – including software solutions, standards, and specifications – for the energy sector to speed decarbonization and the energy transition generally.

LF ENERGY

Why LF Energy?

Energy Ecosystem is now a software challenge & speed of innovation is key!

+ The energy transition requires collaborative, open, and neutral solutions to achieve decarbonization.
+ Open collaboration accelerates innovation to scale, modernize, and digitally transform the energy sector through software orchestration.
+ LF Energy builds communities to develop open technologies, frameworks, reference architectures, and research to alleviate pain points and identify the most urgent priorities to digitally transform the energy sector. This includes cybersecurity, interoperability, control, automation, virtualization, flexibility, and digital orchestration for balancing of supply and demand, which cannot be solved by legacy, proprietary solutions.



LF Energy Key Stats:

- Hosting 30 open source projects covering the energy systems tech stack from generation to distribution to end use
- 75+ members, including utilities, research organizations, traditional energy system vendors, and technology vendors
- Annual increases of:
  - Contributors - 29%
  - Lines of code - 60 million
  - Members - 19%

Where We Add Value:

- Neutral governance providing a home for collaboration across all stakeholders from utilities to researchers, vendors, government, and more
- Project management and hosting infrastructure
- Legal support including licensing, trademarks, etc.
- Communications support including events, thought leadership, etc.
- Community management, to encourage growth, innovation, and determining priorities and direction

LF Energy Members

LFENERGY

LF Energy Member - Strategic (5) +1

LF Energy Member - General (21) +1

LF Energy Member - Associate (38) +3

LF Energy Projects

LFENERGY

LF Energy Projects - Early Adoption (6)

LFENERGY EVerest

LFENERGY GXF

LFENERGY OPERATORFABRIC

LFENERGY POWSYBL

LFENERGY SEAPATH

LFENERGY SOGNO

LF Energy Projects - Incubation (10)

LFENERGY CoMPAS

LFENERGY Dynaωo

LFENERGY FLEDGE POWER

LFENERGY FlexMeasures

LFENERGY Hyphae

LFENERGY OPENEEMETER

LFENERGY openLEADR

LFENERGY OpenSTEF

LFENERGY POWER GRID MODEL

LFENERGY SHAPESHIFTER

LF Energy Projects - Sandbox (8)

LFENERGY ARRAS

LFENERGY Battery Data Alliance

LFENERGY CitrineOS

LFENERGY GRID CAPACITY MAP

LFENERGY GRIP

LFENERGY OpenGEH

LFENERGY OpenSCD

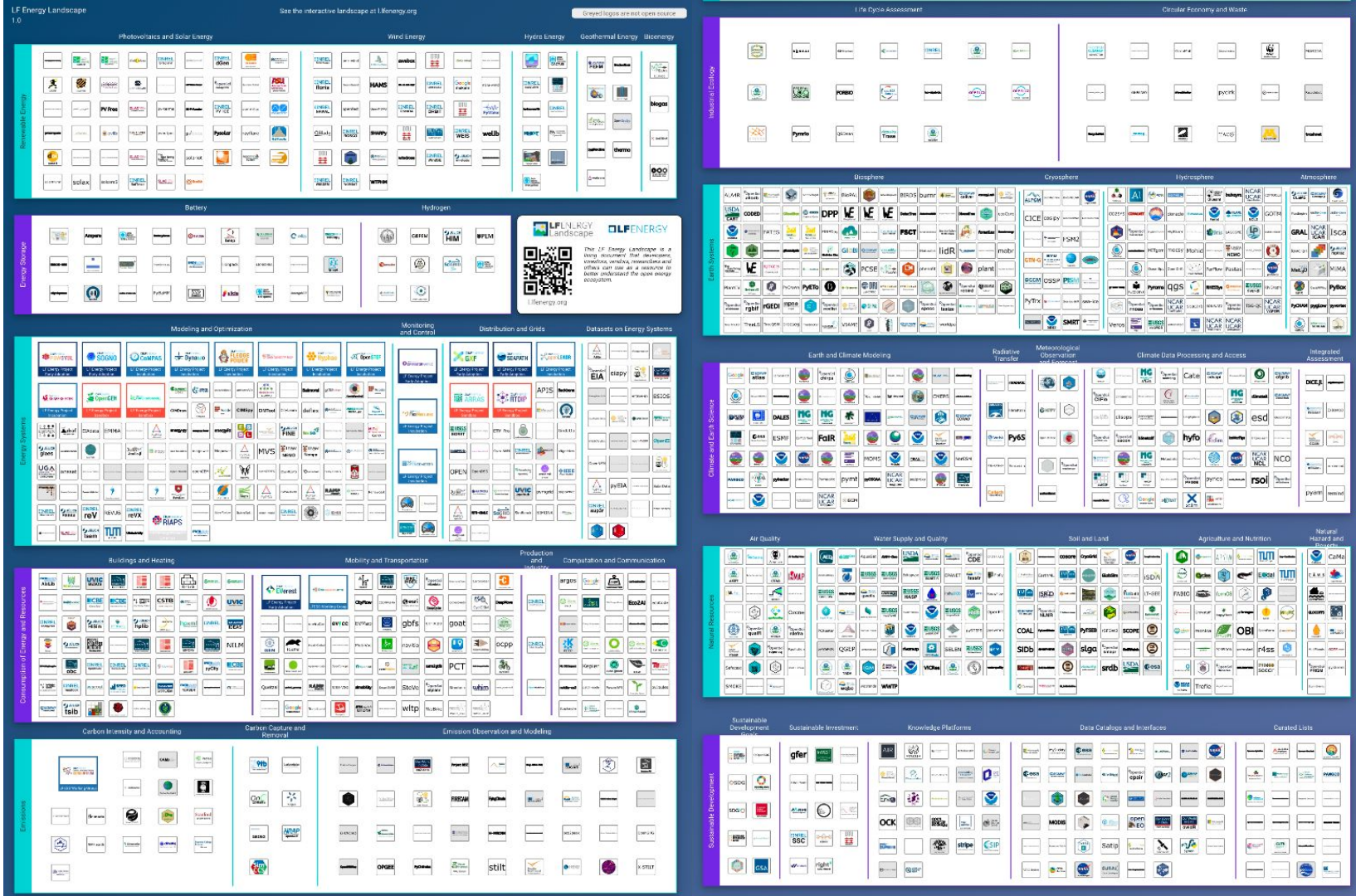
LFENERGY RTDIP

LF Energy Landscape

l.lfenergy.org

1,343 projects, market cap of $7.5T and funding of $17B.

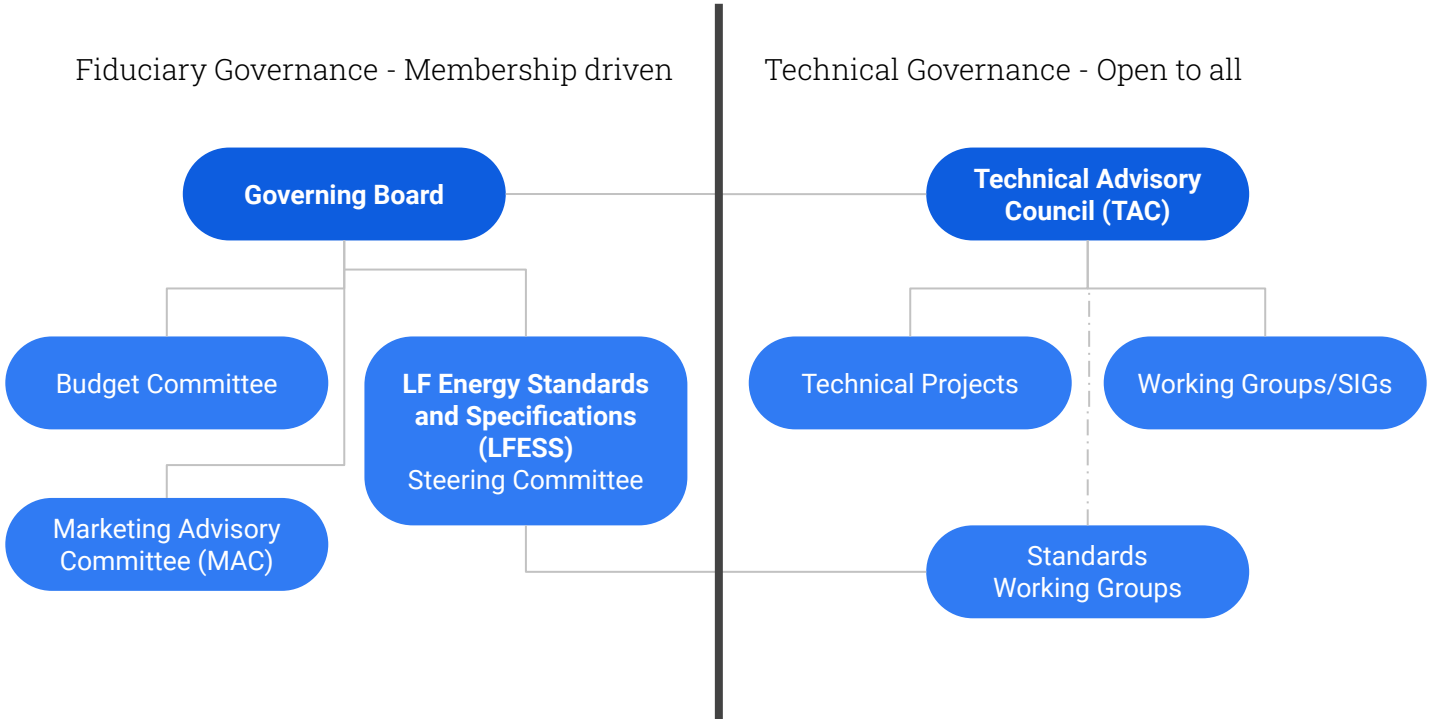
l.lfenergy.org



Governance

LF ENERGY

Governance at a Glance



LF ENERGY

Governing Board overview

Comprised of one (1) voting representative from each Strategic LF Energy member, two (2) annually elected General member, the TAC Chairperson, the Governing Board's responsibilities include:

- Deciding on strategic business orientations, approving budget and new projects
- Electing a Chair to preside over Governing Board meetings, authorize expenditures approved by the budget and manage any day-to-day operations
- Overseeing all Project business, marketing, outreach and trademark matters

LF ENERGY

Governing Board

voting representatives

LF ENERGY

Lucian Balea
Chair
Open Source Program Director
RTE (Reseau de Transport dElectricite)

Antonello Monti
Professor
RWTH Aachen University

Arjan Stam
Treasurer
Value Stream Lead
Alliander

Audrey Lee
Senior Director, Energy Strategy
Microsoft Corporation

Bryce Bartmann
Chief Digital Technology Advisor
Shell International Exploration & Production, Inc.

Jordan Hughes
Senior Software Engineer
Apple Inc.

Marissa Hummon
CTO
Utilidata

McGee Young
CEO
WattCarbon

Savannah Goodman
Data and Software Climate Solutions
Google LLC

Appointing your Governing Board representative

(Strategic Member benefit)

As a Strategic Member, you are entitled to appoint a representative from your organization to serve on the Governing Board.

Expectations of this role:

- Attend monthly Governing Board meetings (1st Wednesday of the month at 8:00 am US Pacific Time)
- Participate in membership recruitment activities, including monthly membership pipeline review call.
- Be available from time-to-time for strategic discussions and calls.

ACTION: To appoint your representative, please file a request at members.lfenergy.org, and have the representative create an LF ID.

You can change your representative at any time by making a request at members.lfenergy.org.

LF ENERGY

Governing Board representative election

(General Member benefit)

Per the LF Energy charter, Section 2(c):

> *General Members, acting as a class, will be entitled to annually elect one representative to the Governing Board for every ten General Members, up to a maximum of three representatives, provided that there will always be at least one General Member representative, even if there are less than ten General Members. The Governing Board determines the election process.*

The General Member class elects new representative(s) during the month of June to serve a term from July 1st through June 30th the following year.

ACTION: Look for details regarding the election in April/May.

If you have any questions about this process or the role, please contact us at members.lfenergy.org.

Dr. Marissa Hummon

CTO at Utilidata

Dr. McGee Young

CEO at WattCarbon

LF ENERGY

Technical Advisory Council (TAC) overview

The TAC is the technical governance heart and soul of LF Energy. As new projects get contributed to LF Energy they get reviewed and approved by this committee.

TAC members consist of Strategic members as well as the project leads for all active projects. Anyone in the community can attend TAC meetings.

The TAC meets every 3 weeks on Tuesdays, and members are invited to attend these calls. Subscribe to the technical mailing list at lists.lfenergy.org/g/tac for more information and add the TAC Meeting to your Calendar Now.

LF ENERGY

Technical Advisory Council (TAC)

voting representatives

LF ENERGY

Antonello Monti

Chair

Professor

RWTH Aachen University

Anne Tilloy

Project manager

RTE (Reseau de Transport dElectricite)

Art Pope

Member of Technical Staff

Google LLC

Boris DOLLEY

Director of OSPO and Sustainable IT Strategy

RTE (Reseau de Transport dElectricite)

Bryce Bartmann

Chief Digital Technology Advisor

Shell International Exploration & Production, Inc.

Jonas van den Bogaard

Open Source Office Lead

Alliander

Maarten Mulder

PO Field Device Platforms

Alliander

Travis Sikes

Senior Data Scientist

Recurve

Yixing Xu

Microsoft Corporation

Appointing your TAC representative

(Strategic Member benefit)

As a Strategic Member, you are entitled to appoint a representative from your organization to serve on the TAC. Expectations of this role:

- Attend TAC meetings held every three weeks on Tuesday at 8:00am US Pacific Time.
- Be available to serve as a TAC mentor to new projects coming into LF Energy
- Participate in out of meeting discussions.
- Be available from time-to-time for strategic discussions and calls.

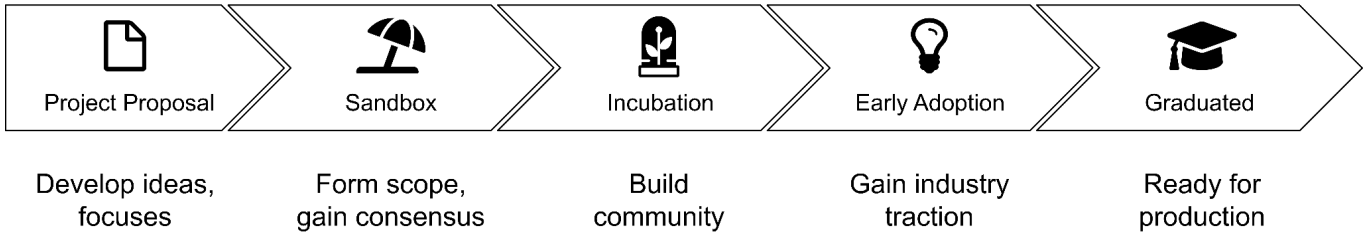
ACTION: To appoint your representative, please file a request at members.lfenergy.org, and have the representative create an LF ID.

You can change your representative at any time by making a request at members.lfenergy.org.

LF ENERGY

LF Energy project lifecycle

- Projects can become part of LF Energy through the submission of a mature code base.
- Projects can also be formed through working groups or special interests groups that submit a proposal and then form as a project.
- Learn more at lfenergy.org/host-your-project



LF ENERGY

Marketing Advisory Committee (MAC)

The MAC advises on marketing and communications strategies including events and campaigns.

The MAC is made up of representatives from all members. There is no cap on the number of committee members.

The MAC meets the 4th Thursday of each month at 7 am US Pacific, and members are invited to appoint a representative to attend these calls.

Recordings and minutes from prior meetings are available publicly.

Member Representatives (**bold** indicates voting member)

Name	Company/organization
Daniel Lazaro	AVEVA
Duncan Johnston-Watt / Csilla Zsigri	BTP
Jonas van den Bogaard	**Alliander**
Chris Xie (Chair)	Futurewei
Mark Caine	**Google**
Matt Fawcett	Carbon Co-op
Christophe VILLEMER	Savoir-faire Linux
VACANT	**Microsoft**
Louisa Durkin	Open Earth Foundation
Nate Kinsey	UtilityAPI
Kelli Littleton	WattCarbon
Aarthi Thyagarajan	**Shell**
Morten Småstuen	Statnett SF
Sheii Lindley	Recurve Analytics
Tim Krentz	Vanderbilt University
Jessica Ridlen	Utilidata
Ben Mosler	PIONIX GmbH
Katia Di Pace	Areti
Boris Dolley	**RTE**
Fabian Kolley	d-fine

LF ENERGY

Appointing your MAC representative

(Open to all members)

As an LF Energy Member, you are entitled to appoint a representative from your organization to serve on the MAC. Expectations of this role:

- Attend MAC meetings held the 4th Thursday of each month at 7 am US Pacific / 10 am US Eastern / 16:00 Central European Time
- Participate in out-of-meeting discussions.
- Be available from time-to-time for strategic discussions and calls.

ACTION: To appoint your representative, please complete this form (select "Marketing/PR" then "Add or Change Marketing Committee Member").

You can change your representative at any time by making a request at the same link.

LF ENERGY

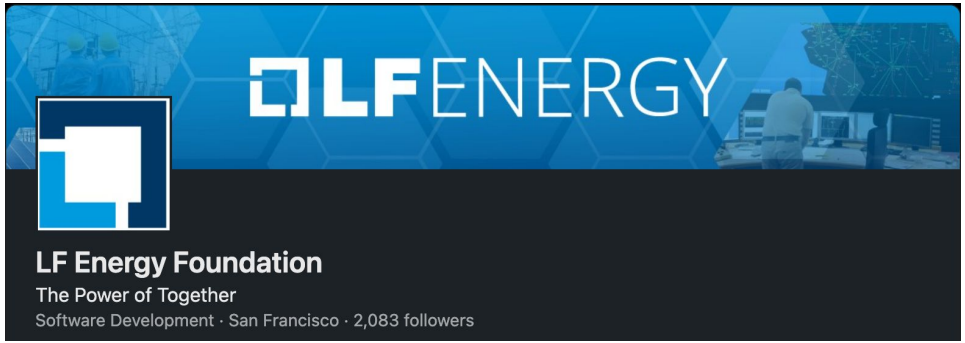
LF Energy staff

- Alex Thornton, LF Energy Executive Director
- Dan Brown, Marketing Director
- John Mertic, Program Director
- Yarille Kilborn, Project Coordinator
- James Sullivan, Membership Solutions

Member support requests of the staff can be made at members.lfenergy.org. Community and project requests can be made at servicedesk.lfenergy.org.

LF ENERGY

Make sure you are following us on social!



Follow us on LinkedIn at
linkedin.com/company/lf-energy-foundation

Follow us on Twitter at
twitter.com/LFE_Foundation

And sign up for the LF Energy newsletter to keep up to date on project happenings

LFENERGY

Leveraging your membership benefits

LF ENERGY

Announcing your membership

We will include your company in an upcoming momentum press announcement. These are typically done quarterly and timed around events for maximum impact.

ACTION: Please provide 1-2 sentences on your company, name of a spokesperson, and a quote to include in the press announcement. Submit request to members.lfenergy.org.

Please note that these announcements are often picked up by press and media, and there may be requests for briefings.

LF ENERGY

Marketing and Event Benefits

The LF Energy staff is here to help you get connected with hosted projects and other members, ensuring value for your investment in the LF Energy Foundation.

All members receive the following benefits:

- Support for member announcements and member PRs
- If member requests, LF Energy will provide quote for member press release or blog
- Logo on the website once your membership has been announced
- Discount on Event Sponsorship packages

ACTION: Contact us at members.lfenergy.org for more details.

LF ENERGY
GENERAL MEMBER

You can get LF Energy member logos to use on your website and materials at artwork.lfenergy.org/other/lf-energy-member/

LF ENERGY

Participate in Standards Development

LF Energy Members can contribute to the specifications being driven under LF Energy Standards and Specifications by completing the membership agreement at joinnow.lfess.energy.

- ➔ As an LF Energy Strategic Member, you receive representation on the LFESS Steering Committee
- ➔ As an LF Energy General Member, you can run for election to serve on the LFESS Steering Committee.

More information on LFESS Governance at https://github.com/lf-energy/lfess-resources/blob/main/GOVERNANCE.md

LF ENERGY
CARBON DATA SPECIFICATION
CONSORTIUM

LF ENERGY
SUPER ADVANCED METER

LF ENERGY

Additional Benefits for Strategic Members

Strategic members are key partners in driving the direction of the LF Energy Foundation, and we partner closely with in driving the mission and vision of the foundation.

Exclusive benefits for Strategic members include:

- Send signal that you are committed and serious about the energy transition and 100% planetary decarbonization
- Guaranteed seat on the LF Energy Governing Board and LF Energy Technical Advisory Council, where your organization can shape where funds are directed, direction of project investments, branding, messaging, PR, marketing, developer events, training
- Placement of member brand at forefront of LF Energy web properties and promotion in top news outlets
- Participation in Linux Foundation Member Summit (Additional Seat)
- Direct assistance with your open source strategy activities, and R&D portfolio, with premium access to the project ED to understand business goals help you succeed in those goals any way possible and premium access to the LF Energy open source leadership to advise member of advancing brand leadership worldwide in open source
- LF Leadership support to keynote member events, participate in outreach (eg roadshows, events, conference meet ups etc..)
- Priority for hosting LF Energy Roadshows and meetups at the location of their choice
- 2x guest blog pieces on LF Energy blog

ACTION: Contact us at members.lfenergy.org for more details.

LF ENERGY

LF ENERGY

STRATEGIC MEMBER

Current Strategic Members

alliander

Google

Microsoft

Rte Le réseau de transport d'électricité

Contact Us

LF Energy Foundation

1 Letterman Drive
Building D, Suite D4700
San Francisco CA 94129
Phone/Fax: +1 415 7239709
www.lfenergy.org

General Inquiries

info@lfenergy.org

Membership

membership@lfenergy.org

LFENERGY

Projects in Detail

LF ENERGY

Early Adoption Stage

The Early Adoption stage is for projects that are operating as an open-source community and are seeing a growing and diverse number of contributors and users of the project.

Projects at the Early Adoption phase are focused on industry adoption and have completed the necessary steps for end-users to be able to consider these projects for future production deployments.

LF ENERGY GXF

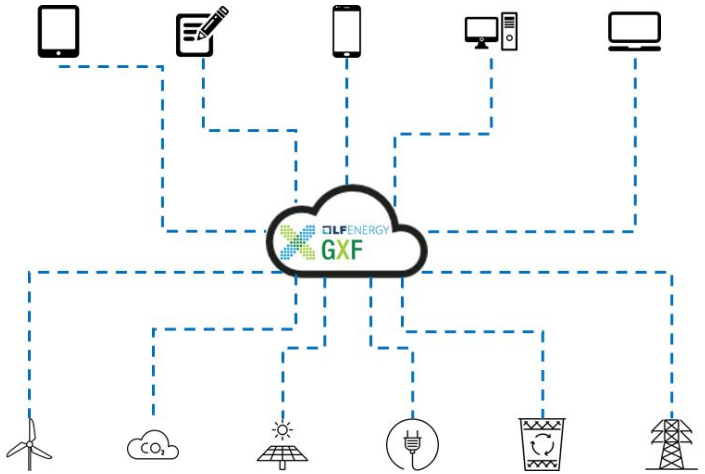
Software platform that enables hardware monitoring and control in the public space at scale

Top Use Cases

- **Smart Metering**: At DSO Alliander GxF is the Back-end platform for the Smart Meter Head End. There we use different Dutch protocols to communicate with the smart meters. We do that for 3.4 million devices.
- **Distribution Automation**: At this moment we support via MQTT Low voltage measurements. In the future we want to implement also a gateway device so that more digitalization is possible in the DA Space. In the end 26.000 devices are connected.
- **Flex OVL**. In 33% in the Netherlands we switch the public lighting via 16.000 RTU's. GxF makes it possible to work with a lux signal and give also the municipalities the possibility to switch via their own schema

Technical Summary

- Designed as a middleware component for a DSO/TSO to standardize on, or can be used in as the framework in a vendor application stack.
- Project contributed by Alliander



Learn more at gxf.energy

Central Supporting Services

Acquisition and Control
Infrastructure Management

LF ENERGY

LF ENERGY
OPERATORFABRIC

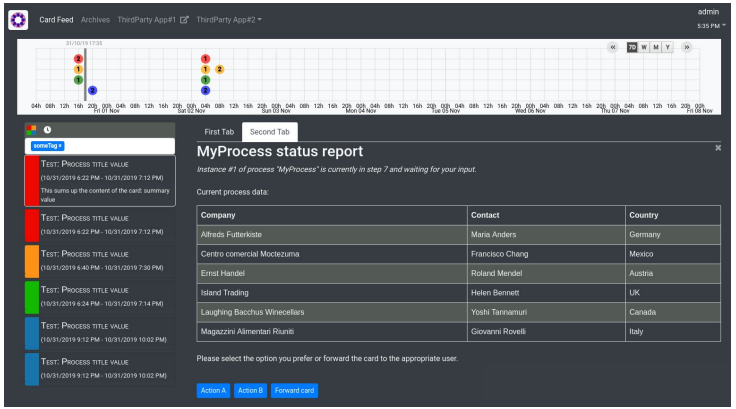
Modular, extensible platform for alert management for systems operators.

Top Use Cases

- Electricity, water, and other utility operational dashboard for managing field devices and alert response
- Organizational power system coordination, visibility, communication, and workflow between distributed users across national and regional boundaries.

Technical Summary

- Written in Java and based on the Spring framework
- Contributed by RTE



Learn more at operatorfabric.energy

Business Intelligence

Shared
Unified Operator's UX Components and Framework

LF ENERGY

LF ENERGY POWSYBL

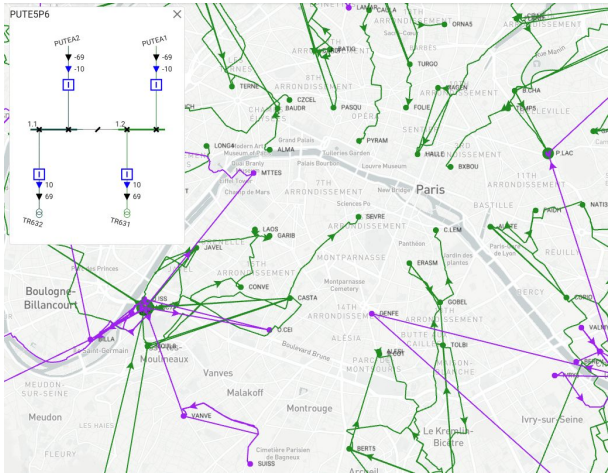
Open source library dedicated to electrical grid modeling and simulation

Top Use Cases

- Dynamic power flow simulations and security analyses across a power grid
- Data exchanges using a variety of formats including ENTSO-E CIM/CGMES, UCTE-DEF, and more.

Technical Summary

- Written in Java
- Can be used for one-off scripting and scale up to production application usage.
- Contributed by RTE



Learn more at powsybl.energy

Business Intelligence

System Management
Power System Calculation

LF ENERGY

LF ENERGY SOGNO

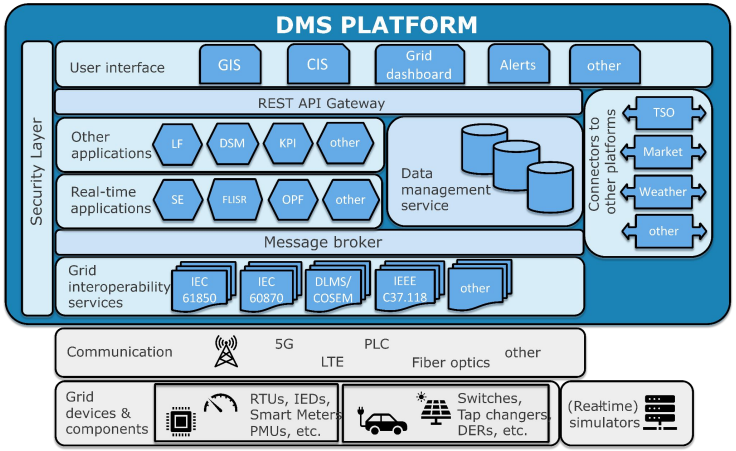
Microservice based architecture for distribution grid automation

Top Use Cases

- State Estimation
- Load Prediction
- Voltage Control

Technical Summary

- Microservices architecture; designed to be deployed using Kubernetes, either in the cloud or at the edge
- Seamless integration of development, testing, and deployment enables new automation functionalities to be developed and thoroughly tested against a virtual real-time representation of the power system before deployment.
- Developed under European Union's Horizon 2020 research and innovation programme under grant agreement No 774613, and open sourced by RWTH.



Learn more at sogno.energy

Business Intelligence

System Management
System Control

LF ENERGY

Incubation Stage

Incubation projects are projects which the TAC believes are, or have the potential to be, important to the ecosystem of Projects or ecosystem as a whole. They may be early-stage projects just getting started, or they may be long-established projects with minimal resource needs. The Incubation stage provides a beneficial, neutral home for these projects in order to foster collaborative development and provide a path to deeper alignment with other LF Energy projects.

LF ENERGY CoMPAS

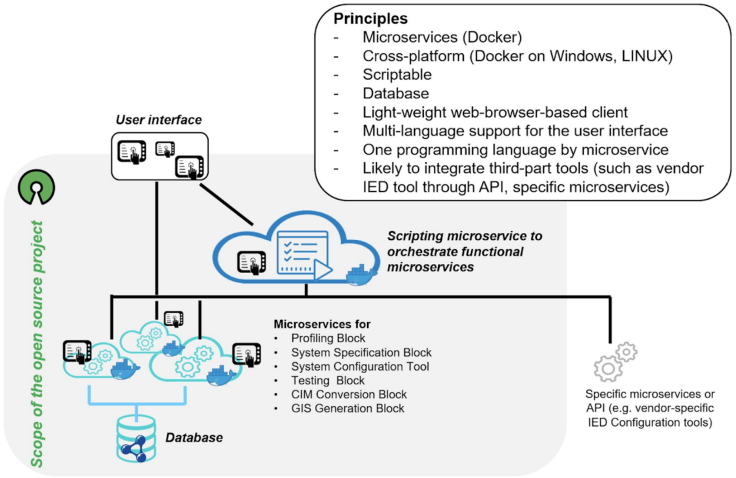
Common software blocks for IEC 61850 profile configuration

Top Use Cases

- SCL data management / SCL data storage service: store and load SCL files / SCL Files versioning
- CIM to IEC61850 conversion
- Display/edit SCL files e.g.
- GOOSE/Sample value subscription

Technical Summary

- Reference implementation of the IEC 61850 standard
- Uses cross-platform Docker-based microservices along with a browser client, scriptable controls, and the ability to integrate third-party tools.
- Project contributed by Alliander



Learn more at compas.energy

Central Supporting Services

Acquisition and Control
Substation Node

LF ENERGY

LF ENERGY EVerest

Open source modular framework for EV charging

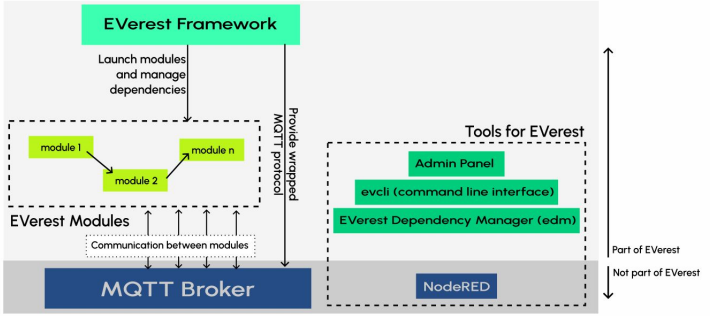
Top Use Cases

Manage communication around energy between different players:

- Car (EN IEC 61851, ISO 15118)
- Local energy generation & batteries (Modbus, Sunspec)
- Adjacent chargers (WIP)
- Grid (including specific grid constraints)
- Cloud backend / payment (OCPP 1.6)
- User (interface)

Technical Summary

- Consists of multiple modules which can be enabled/disabled depending on the deployment, all connected via a MQTT server.
- Contributed by PIONIX GmbH



Learn more at everest-project.energy

SGAM Domains
DER, Customer Premises

SGAM Zones
Field

LF ENERGY

LF ENERGY

FLEDGE POWER

Flexible, lightweight, industrial-grade, open source gateway that embeds Fledge (LF EDGE)

Top Use Cases

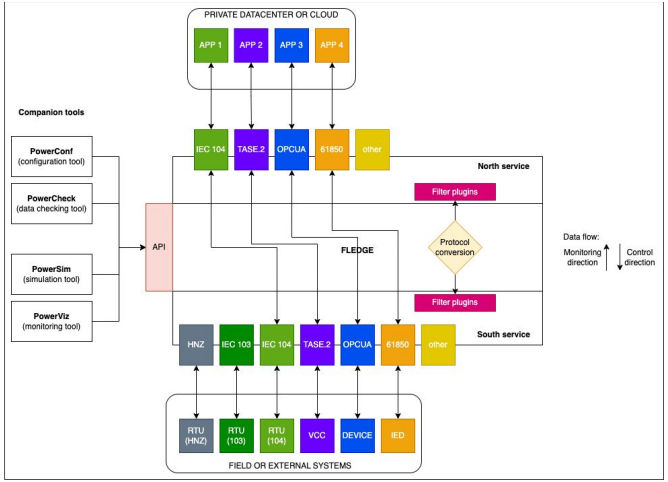
- Improving the availability of an IEC 104 substation by deploying FledgePower with multi-centre IEC 104 redundancy.
- Securing an old generation substation in HNZ protocol, by deploying FledgePower with IEC 104 over TLS.
- Power grid simulation, using FledgePower to integrate with the substation in IEC 104 on the one hand and the simulation system in OPCUA on the other.

Technical Summary

FledgePOWER solves the problem of multiple protocols by providing the industry with a flexible, lightweight, industrial-grade, open source gateway that embeds Fledge (LF EDGE). Additionally, FledgePOWER provides a toolbox for simulation, data configuration, and checking focused uniquely on power systems' protocols translation and power systems' use cases.

FledgePOWER is a cross foundation collaboration between LF Edge and LF Energy that ensures strong cooperative governance and technical alignment between the two communities.

Project contributed by RTE



Learn more at fledgepower.energy

Edge & Distributed Intelligence

Acquisition and Control
Communication Infrastructure

LF ENERGY

LF ENERGY FlexMeasures

Intelligent & developer-friendly EMS to support real-time energy flexibility apps, rapidly and scalably

Top Use Cases

The problem it helps to solve is “What are the best times to run flexible assets, like batteries, heat pumps or industry processes?”

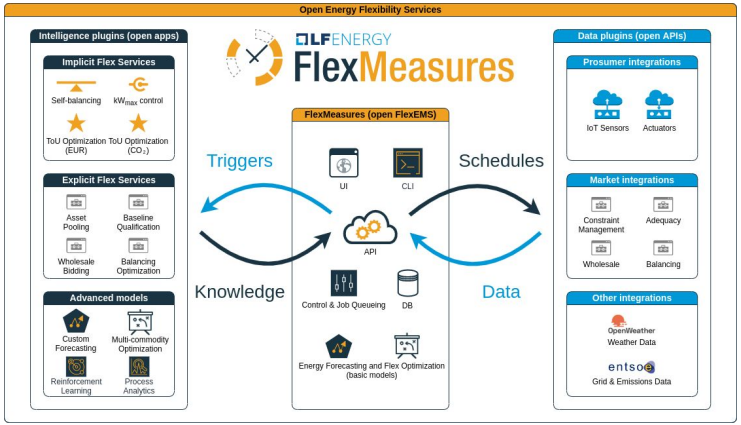
- Industry: Shift process running times to minimize balancing costs as well as CO2 & support network congestion
- Built Environment: Optimize heating to satisfy comfort and energy costs (use rooftop solar & dynamic tariffs)
- E-Mobility (optimal charging time to lower bills, including vehicle-to-grid)

Technical Summary

FlexMeasures is designed to be developer-friendly, which helps you to go to market quickly, while keeping the costs of software development at bay. FlexMeasures supports:

- Real-time data integration & intelligence
- Model data well — units, time resolution & uncertainty (of forecasts)
- Faster app-building (API/UI/CLI, plugin & multi-tenancy support)

Contributed by Seita BV



Learn more at flexmeasures.energy

Business Intelligence

Asset Management
Data Management

LF ENERGY

LF ENERGY GRID CAPACITY MAP

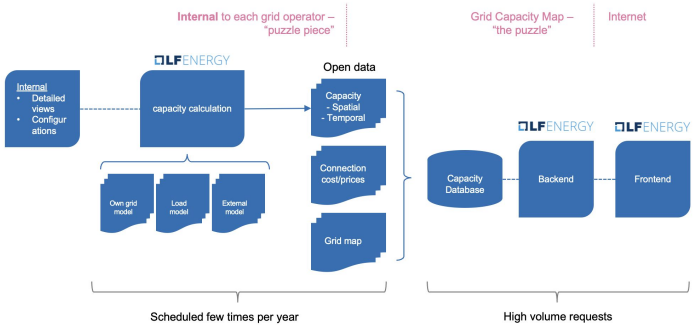
Enable grid operators - and the customers they serve - to more easily see when and where connections will be most optimal

Top Use Cases

- Ensure customer and stakeholders expectations on grid connections are realistic to give a better connection experience with fewer surprises for both grid owner (DSO/TSO), grid customers and other stakeholders.
- Giving a utility ability to advise a company to move locations to get connection sooner.

Technical Summary

- Built in Python; using the panda power grid model and power flow calculation
- Contributed by Vattenfall Eldistribution AB



Learn more at gridcapacitymap.energy

Business Intelligence

System Management
Power System Calculation

LF ENERGY

LF ENERGY Hyphae

Open-source control for AC, DC, AC/DC microgrids

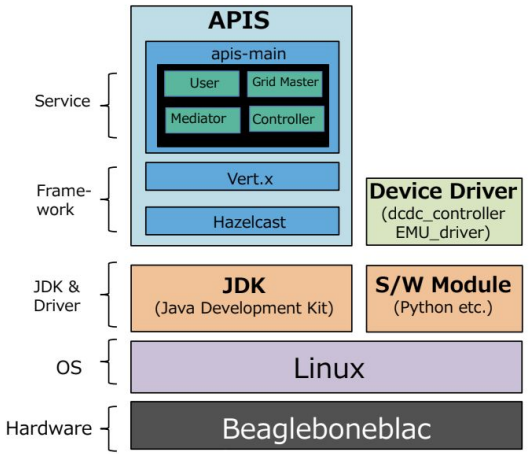
Top Use Cases

- Autonomous Power Interchange System: P2P control of batteries charging/discharging in DC microgrid
- Converter controller with plug-and-play capability

Technical Summary

Hyphae aims at building open-source control for AC, DC, AC/DC microgrids. This refers to component-level control and system-level control. The former includes plug-and-play control for power electronics converters that interface the distributed energy resources of the microgrid. The latter includes coordination control of all components in the microgrid and control for the islanding and grid-connection of the microgrid to the main distribution grid. The project aims also at power flow control between several microgrids, enabling ancillary services provided to the distribution grids. This is distributed, modular and scalable control, to enable flexible expansion of microgrids.

Project contributed by Sony Computer Science Laboratories.



Learn more at hyphae.energy

Edge & Distributed Intelligence

Acquisition and Control
Edge Node Control

LF ENERGY

LF ENERGY OPENEEMETER

Computing consistent and replicable estimates of changes in time series of energy consumption, primarily as measured for populations of commercial and residential buildings.

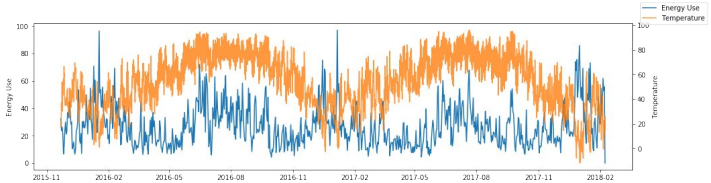
Top Use Cases

OpenEEmeter, as implemented in the eemeter package and its companion eeweather package, contains the most complete open source implementation of the CalTRACK methods, which specify a family of ways to calculate and aggregate estimates avoided energy use at a single meter particularly suitable for use in pay-for-performance (P4P) programs

Technical Summary

OpenEEmeter emphasizes consistency and replicability to facilitate payments and market transactions that may be take the energy savings outputs of the software as inputs.

Project contributed by Recurve



Learn more at openeemeter.energy

Business Intelligence

Customer and Market

Customer Relationship and Communication

LF ENERGY

LF ENERGY openLEADR

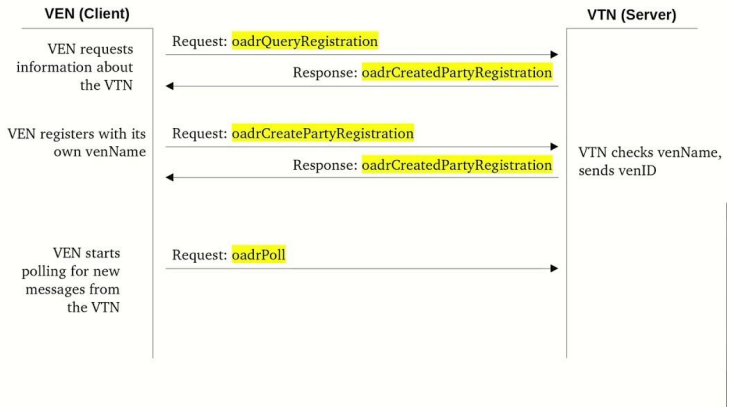
Software stack that predicts future load on the electricity grid using machine learning

Top Use Cases

- Computes revenue-grade impacts of residential and commercial demand flexibility, such as energy efficiency projects, behavioral interventions, and demand-response events.
- Documents standard approaches and reasoning behind methodological approaches to data modeling.
- Supports methods development and model testing.

Technical Summary

- The stack is based on open source technology, organized in a microservice architecture, and optimized for cloud-deployment.
- Contributed by ElaadNL and OpenADR Alliance



Learn more at openleadr.energy

Edge & Distributed Intelligence

Acquisition and Control
Edge Node Control

LF ENERGY

LF ENERGY OpenSTEF

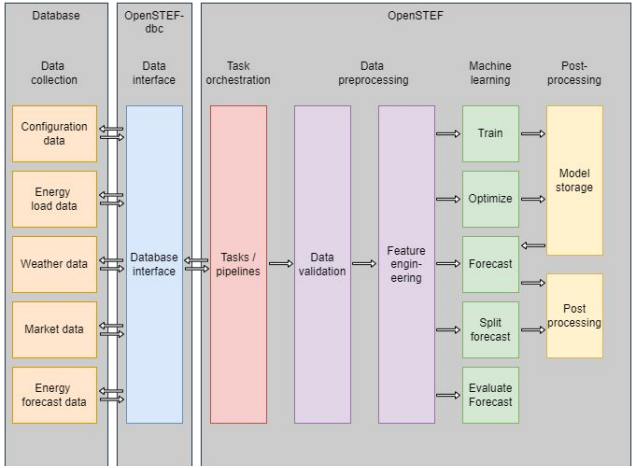
Predict future load on the electricity grid using machine learning

Top Use Cases

- Forecasting load at the DSO/TSO interface
- Forecasting load for the DSO to perform congestion management
- Forecasting load on secondary substations or individual customers to facilitate smart-grid applications

Technical Overview

- OpenSTEF validates input data, uses external predictors such as weather and market prices, trains machine learning models, and provides a forecast via API and graphical user interface.
- The stack is based on open source technology, organized in a microservice architecture, and optimized for cloud-deployment.
- Project contributed by Alliander



Learn more at openstef.energy

Business Intelligence

System Management
Power System Calculation

LF ENERGY

LF ENERGY SEAPATH

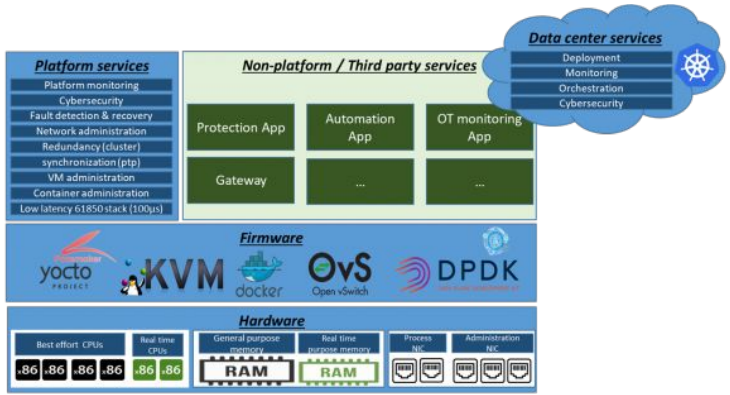
Enables building a real-time virtualization industrial-grade platform based on Yocto or Debian

Top Use Cases

- By vendors to build a fully virtualized digital substation and ensured to its client that it is based on open source
- By integrators that wants to propose and support a real-time virtualization industrial-grade platform for their clients
- By utilities, universities and start up that want to evaluate their concepts and take benefit of this collaboration framework.

Technical Summary

- The technology behind SEAPATH includes the use of Ceph storage, Linux RT, Pacemaker for high availability, Open vSwitch (OVS) for network virtualization, SR-IOV for hardware acceleration, KVM for virtualization, and PTP synchronization for accurate timekeeping
- Contributed by Alliander and RTE



Learn more at seapath.energy

Edge & Distributed Intelligence

Acquisition and Control
Substation Node

LF ENERGY

LF ENERGY SHAPESHIFTER

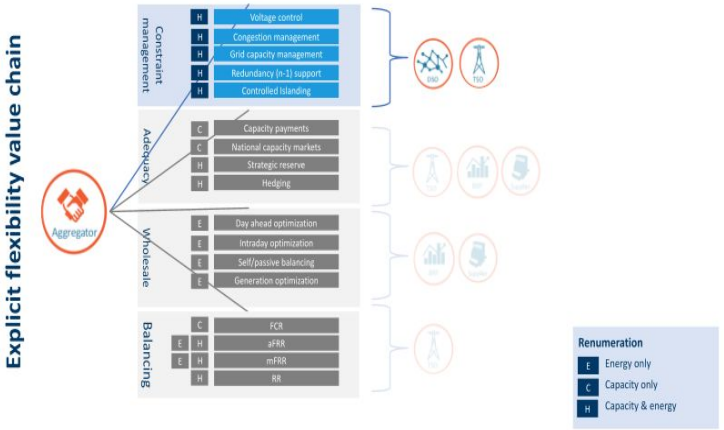
Implements the Universal Smart Energy Framework for flexibility forecasting, offering, ordering, and settlement processes.

Top Use Cases

- Exchange of flexibility between aggregators (AGRs) and distribution system operators (DSOs) or between aggregators and transmission system operations (TSOs).
- Enables DSO and TSO to resolve grid constraints by applying congestion management or grid capacity management

Technical Summary

- Based on the market-based coordination mechanism (MCM) described by USEF
- Contributed by GOPACS



Learn more at shapeshifter.energy

Business Intelligence

Customer and Market
Market Platform Gateway

LF ENERGY

Sandbox Projects

Projects being submitted to the LF Energy at the sandbox level are intended to be the entry point for early-stage projects. Characteristics for projects at the Sandbox Stage maybe one or more of:

- Early-stage projects that the LF Energy TAC believes warrant experimentation.
- New projects that are designed to extend one or more TAC projects with functionality or interoperability libraries.
- Independent projects that fit the LF Energy mission/vision and provide the potential for a novel approach to existing functional areas (or are an attempt to meet an unfulfilled need).
- Projects commissioned or sanctioned by LF Energy, including initial code for LF Energy Working Group collaborations, and "experimental" projects.
- Any project that realistically intends to join LF Energy Incubation in the future and wishes to lay the foundations for that.

LF ENERGY ARRAS

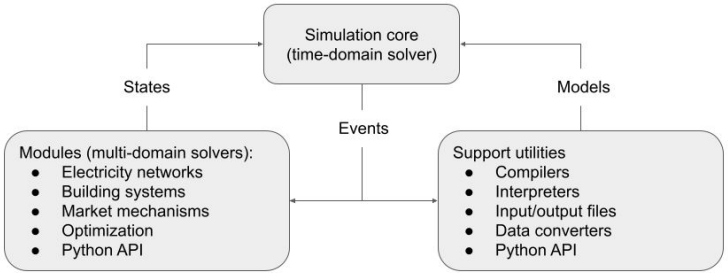
Simulation and analysis tool that models emerging smart grid energy technologies

Top Use Cases

- Distributed energy resource hosting capacity, tariff design, and end-use load electrification
- Extreme weather resilience and wildfire safety and protection,
- Peer-to-peer energy and advanced load modeling and forecasting.

Technical Summary

- Originally called HiPAS GridLAB-D.
- Primarily built in C++ and Python.



Learn more at arras.energy

Central Supporting Services

System Management
Power System Calculation

Project contributed by California Energy Commission and US Department of Energy Cybersecurity Energy Security and Emergency Response Office

LF ENERGY

LF ENERGY Dynaωo

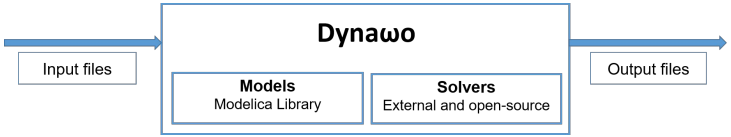
Hybrid C++/Modelica open source suite of simulation tools for power systems

Top Use Cases

- Power system simulations
- Decision making on operational grid needs

Technical Summary

- Hybrid C++/Modelica codebase
- Project contributed by RTE



Learn more at https://lfenergy.org/projects/

Business Intelligence

System Management
Power System Calculation

LF ENERGY

Platform for interorganizational data interchange, data and model synthesis, and system performance analysis between different power systems tools

Top Use Cases

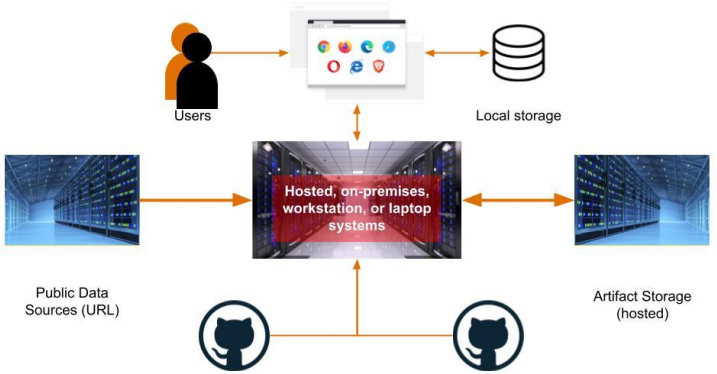
- Data collection, curation, and synthesis
- Shared/standardized analysis, modeling, and simulation methods
- Data delivery, sharing, and dissemination.

Technical Summary

OpenFIDO can be used to (1) collect data from a wide variety of open sources, private databases, and commercial product; (2) transfer model and telemetry data between various tools that are part of the suite of tools widely used by utilities, distributed energy resource (DER) engineers and regulators in California; and (3) provide the ability to create permanently available reproducible results.

Project contributed by California Energy Commission and US Department of Energy Cybersecurity Energy Security and Emergency Response Office

OpenFIDO Technical Approach: Platform architecture



LF ENERGY

LF ENERGY
POWER GRID MODEL

High performance distribution grid calculation model

Top Use Cases

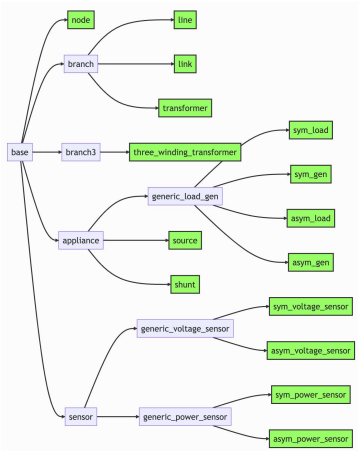
- Short term real-time state estimation and forecasting
- Long term grid planning
- Congestion management

Technical Summary

Power Grid Model has a C++ calculation core with a mature C-API and Python API. Currently, it supports the following calculations:

- Symmetric and asymmetric power flow calculation with Newton-Raphson method, iterative current method and linear method
- Symmetric and asymmetric state estimation with iterative linear method

Project contributed by [Alliander]



Learn more at [powergridmodel.energy]

Business Intelligence

System Management
Power System Calculation

LF ENERGY

LF ENERGY OpenGEH

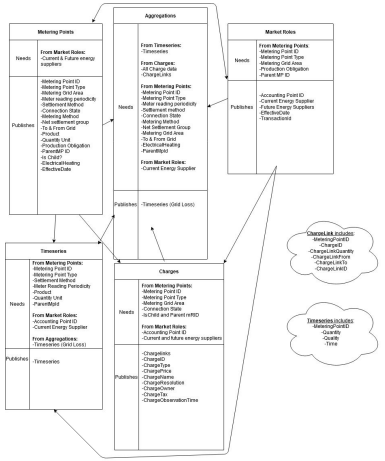
Enables fast, flexible settlement and hourly measurements of production and consumption of electricity

Use Cases

- Help utilities to onboard increased levels of renewables by reducing the administrative barriers of market-based coordination

Technical Summary

Contributed by Energinet and Microsoft.



Learn more at opengeh.energy

Business Intelligence

Shared
Data Management

LF ENERGY

LF ENERGY RTDIP

Easy access to high volume, historical and real time process data for analytics applications, engineers, and data scientists wherever they are.

Use Cases

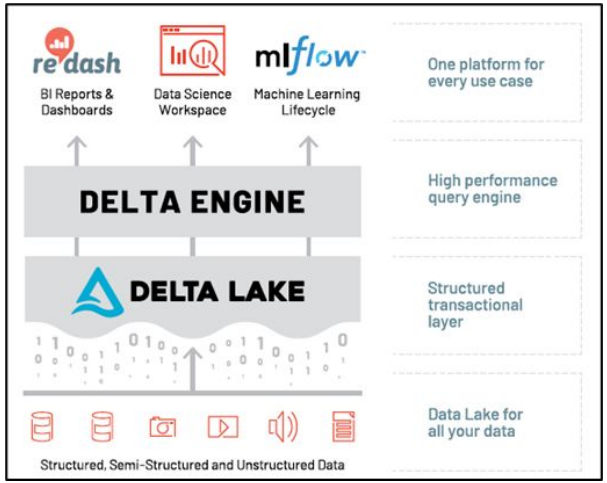
- Process time series data for preventive maintenance management

Technical Summary

Key components are:

- The Delta Ingestion engine used to process streaming data from streaming sources and files stored in cloud storage into Delta format.The data ingested is typically sourced from Pi Historians, OPC UA Servers, IoT Devices 2.
- Python SDK that enables data consumers to read and queryraw, sampled, interpolated or time weighted averages of the data stored in Delta3.
- REST APIs that are wrappers forthe Python SDK that enable developers in non-python languages to consume the data

Contributed by Shell



Learn more at rtdip.io

Edge & Distributed Intelligence

System Management
Data Management

LF ENERGY

LF ENERGY

Standards and Specifications

Working Groups

LF ENERGY
CARBON DATA SPECIFICATION
CONSORTIUM

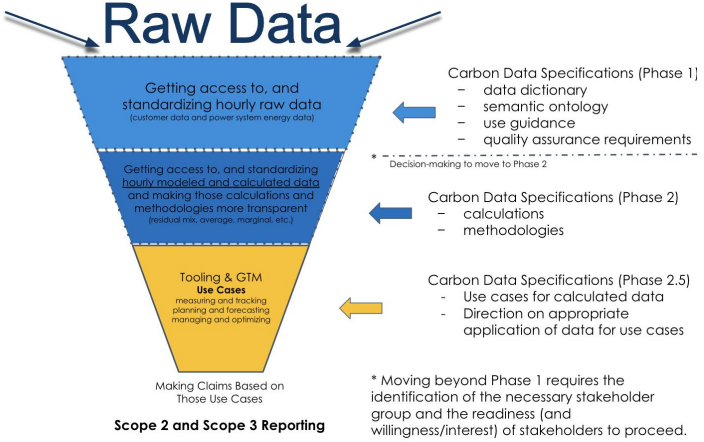
Specifications for the underlying measured/raw data used to calculate energy and carbon-related metrics.

Use Cases

- Customer data. This may include, but is not limited to:
  - Metering consumption and production data
  - Account and bill data needed for project analysis
  - Authorization and consent processes
- Power systems data. This may include, but is not limited to:
  - Power generation emissions
  - Delivery capacities and/or constraints
  - Generation mix
  - Power imports and exports
  - Power market data
  - Contractual data

Technical Summary

Data dictionary for raw data and a standard for data requirements that enable energy data access for measuring, quantifying, and tracking carbon emissions from energy production and consumption.



Learn more at carbondataspec.org

Central Supporting Services

Asset Management
Data Management

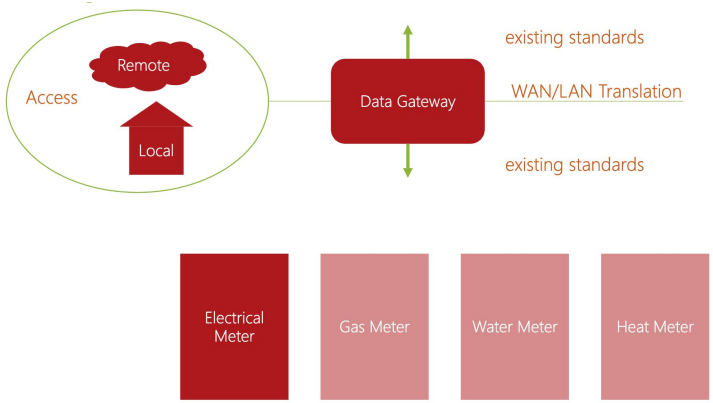
LF ENERGY

LF ENERGY SAM

Worldwide applicable meter and respective data gateway specification

Use Cases

- Basic metering functionality
- Country-specific functionality
- Third party functionality and integration capability for system operation applications



Technical Summary

Standards collaboration

Contributed by Utilidata and Alliander

Learn more at superadvancedmeter.energy

Central Supporting Services

Customer and Market
Customer Relationship and Communication

LF ENERGY