Housekeeping

- The webinar is being recorded and will be shared with attendees.
- To adjust audio:
  - Computer audio - select “Audio Settings” and check sound output and volume.
  - Dial-in by phone - Dial-in numbers can be found in your registration confirmation email.
- To ask a question:
  - Select Q&A, type in question, and select Send.
- To make a comment, please use the Chat function, and send to “Everyone”.
Global Power System Transformation (G-PST) Consortium

**What?**
A new global Consortium focused on support to power system operators with advanced high RE & other low-emission solutions

**Who?**
Founding System Operators

**How?**
5 Pillars

1. System Operator Research and Peer Learning
2. System Operator Technical Assistance
3. Workforce Development
4. Localized Technology Adoption Support
5. Open Tools and Data

G-PST Core Team Technical Institutes

Developing Country System Operators - Confirmed partners - Indonesia, Vietnam, India, South Africa, and Peru
How You Can Engage

• Join our network to receive webinar invitations, our newsletter and other important updates - [https://globalpst.org/get-involved/](https://globalpst.org/get-involved/).

• Engage in our regional peer learning networks and/or pillar groups – submit interest in particular pillars through the website - [https://globalpst.org/get-involved/](https://globalpst.org/get-involved/)

• Reach out to explore remote light touch technical assistance or with any questions at: [globalpst@nrel.gov](mailto:globalpst@nrel.gov)
Pillar 5 Introduction
Building an Open-Source Strategy at Power Grid Operators

- Why build an open source capacity at power grid operators?
- What does an open source roadmap look like?
- What are the expected challenges, lessons, and experiences?
What did you do during the Great Transition?
7,874,965,825 people onboard
Growth of fossil-fuel, CO2 emissions and global GDP since 1700

World GDP $108 trillion

CO2 Emissions 36.44 billion tons

Fossil-fuel consumption 120,000 TWh

Composed from data found at OurWorldinData.org
The Power of Together
Power systems lead global decarbonization efforts

Power systems + Transportation + Built Environment = 73% of carbon emissions!
We Only Have 8 Years!
Design **Challenge**

- Not enough time
- Not enough resources
- We need interoperability
- And, no vendor lock-in
Open Source
What is open source?

Source code that anyone can inspect, modify, and enhance

**Control.** Developers have access and can examine the code

**Security.** Developers can fix, update, and upgrade

**Community.** Inspires users and developers to form around it

**Interoperability.** Incorporate open standards

**Shared development.** Enables collective investment!

**FASTER, CHEAPER, MORE SECURE,**
Open Source Isn’t Slowing Down Any Time Soon

The Power of Together
The real question is: Which projects really matter?
Linux Foundation and LF ENERGY seek to accelerate new projects to adoption and sustainability.
Providing a 21st century plan of action to decarbonization through open source, open frameworks, reference architectures, and a support ecosystem of complementary projects.
At the heart of LF Energy is Governance

- **Governance Board**: Oversees business decisions, budgets, outreach, marketing/events, trademarks, etc.
- **Technical Steering Committee**: Leads projects and oversees collaboration with upstream
- **Marketing Committee**: Oversees marketing, communication, outreach, events, training
- **Project Communities**: Deliver software releases

Splitting business and technical decision making is a best practice for open source projects.
Governance Model

OLF Energy

Governing Board
- Legal Committee
- Budget & Finance Committee
- Marketing, Education, and Outreach Committee
- ... others

Technical Advisory Council
- TSC #1
  - Maintainers/Committees
  - Contributors
- TSC...#N
  - Maintainers/Committees
  - Contributors

The Power of Together
LF Energy Projects (+4)

- Fledge
- Power
- SOGNO
- Shapeshifter
- Grid Exchange
- Fabric
- Operator
- Fabric
- Compas
- Open Leadr
- Hyphae
- Grid Capacity Map
- PowSyBL
- Seapath
- Open EeMeter
Business Intelligence

Central Supporting Services

Edge & Distributed Intelligence
Core Business
Supporting Services

Data Exchange Gateways

- IoT Platform
- Network Security Coordination
- Market
- SO Data Exchange

Core Business
Supporting Platforms

- Digital Twins
- Project N...
- Network Security Assessment and Optimization
- State Estimation and Network Model Optimization
- Congestion Management and Power Flow Optimization

Business Intelligence

- Power System Calculation Block
- Power System Automation Architecture
- Short-term forecasting
- OpenSTF (logo to follow)
- NMEC and Avoided Energy Use

Data and Services Platforms - Baikal (OSDU), FIWARE, TimeScale Db, DataBricks, homemade

Infrastructure

- Network Model Manager
- Alarm Management

Configuration & Validation Tools

- Configuration & Validation Tools
- 61850 Substation Configuration

API (standard interface for accessing and storing the data)

REAL TIME Event Orchestration Layer (Kafka, MQTT, ONAP? etc) [analysis]

Data and Services Platforms - Baikal (OSDU), FIWARE, TimeScale Db, DataBricks, homemade

Security

- Flex Measures (logo to follow)
- GreenData Hub (logo to follow)

For more background on Edge see this.
We are building a grid that is beyond our ability to intellectually “manage”
Power System Building Blocks

5G, edge, IoT, cloud native, distributed computing, control, orchestration, choreography, AI, ML
The Power of Together
MASSIVELY DISTRIBUTED

CONNECTED VEHICLES

CONNECTED BUILDINGS

CONNECTED MARKETS

CONNECTED INFRASTRUCTURE

CONNECTED ASSETS

CONNECTED HOMES

CONNECTED VEHICLES
We need to network electrons!
Membership Model
### Membership and Participation Levels

<table>
<thead>
<tr>
<th>Membership Level</th>
<th>Annual Fee</th>
<th>Plus Linux Foundation Membership: Silver (if not a member)</th>
<th>Board Seat</th>
<th>TSC Seat</th>
<th>Outreach Committee</th>
<th>Suggested Minimum FTE*</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic</strong></td>
<td>Flat fee: $150k</td>
<td>$20k</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>1</td>
<td>Two year minimum commitment</td>
</tr>
</tbody>
</table>
| **General**      | $5k-50k based on org size¹ | Based on number of employees  
$20K (5000+)  
$15K (499-4999)  
$10K (100-499)  
$5,000 (0-99) | (Possible) 1 per every 10 General members | Based on Merit | Yes | N/A | A TSC seat may be earned by technical contribution as a project leader |
| **Associate**    | No fee | No | (Provisional at start-up) | Based on Merit | Yes | N/A | Limited to academic, research and NGO organizations |

**General Annual Fee Scale**  
- $50K - > 5,000 employees  
- $30K - 1,000 – 4,999 employees  
- $20K - 200 – 1,000 employees  
- $10K -100 – 200 employees  
- $5K -< 100 employees  

*FTE = Full Time Equivalent (e.g. 2 employees each spend 50% of their time on a project). This suggestion is meant to provide a minimum resource investment to ensure members are contributing technically. Most projects see much higher investment of resources than the minimum requirement.*
## LF Energy Membership Benefits

<table>
<thead>
<tr>
<th>Details</th>
<th>Strategic</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaranteed seat on the LF Energy Governance Board - shape where funds are directed</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Guaranteed seat on the LF Energy Technical Advisory Council - shape the direction of projects</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Host strategic and critical projects and lead industry efforts</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>Direct oversight and influence on all of LF Energy, including access to briefing on the pipeline and inclusion of new projects</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Direct ability to govern and create new projects</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Direct influence on messaging, PR, marketing, developer events, training</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Budget Influence/approval, how and where the project spends money</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Advise member of advancing brand leadership worldwide in open source</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Promotion in top news outlets</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Placement of member brand at forefront of LF Energy web properties</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Participation in Linux Foundation Member Summit (Additional Seat)</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
## LF Energy Membership Benefits

<table>
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<th>Strategic</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Direct assistance with your open source strategy activities, and R&amp;D portfolio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Send signal that you are committed and serious about the energy transition and 100% planetary decarbonization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premium access to the project ED to understand business goals help you succeed in those goals any way possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premium access to the LF Energy operations staff. This is across all LF Energy functions like IT and technical expertise across projects in the Linux Foundation ecosystem, Marketing, and Operations,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participate in any cross project strategy discussions on harmonization and future direction of LF Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LF Leadership support to keynote member events, participate in outreach (eg roadshows, events, conference meet ups etc...)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Priority for hosting LF Energy Roadshows and meetups at the location of their choice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2x guest blog pieces on LF Energy blog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support for member announcements and member PRs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If member requests, LF Energy will provide quote for member press release or blog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logo on the website once your membership has been announced.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount on Event Sponsorship packages</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Isolation and going it alone are no longer viable.
We need mass collaboration.
For Further Information

Shuli Goodman
Executive Director
Linux Foundation Energy
sgoodman@lfenergy.org

Our Website: https://lfenergy.org
Membership: https://www.lfenergy.org/join
Mailing Lists: https://lists.lfenergy.org
Our Wiki: https://wiki.lfenergy.org
Building an open source strategy at a power grid operator

Lucian Balea, Open Source Program Director, RTE
27 October 2021
We want to meet the power system transformation challenges while preserving operational performance.
GOOD + FAST + CHEAP?

Necessity to increase tenfold the speed, cost-efficiency and innovation of core-business software development projects.
Building an Open Source capacity aiming at…

- an acceleration by reusing what exists and sharing efforts, allowing to build faster and cheaper software,
- improved modularity, interoperability, evolutivity and shorter release time cycles,
- cutting-edge technological and business model innovation,
- access, through collaboration, to wider and more diverse skills and to a diversity of viewpoints,
- reduced vendor lock-in or customer-specific approaches that impede velocity and cost-efficiency.
& let’s apply proven best practices and avoid reinventing the wheel…

Providing a 21st century plan of action to decarbonization through open source, open frameworks, reference architectures, and a support ecosystem of complementary projects.
And concretely? 4 unexpected TSO/DSO collaborations have grown up!
Think big

- Imagining and triggering a shift at corporate and even industry levels

start soon and small, “fail” fast

- Practicing helps demystifying
- Learning and onboarding from communities
Open Source?

LFE obviously!
Global transition from DNO to DSO

- We have customers, this time for real!
- Strategic chaos, what first and how?
- Help! We need energy system architecture for energy management
- How to utilize energy system control complexity on climat goals
- We need disrupting innovation
- How to deal with the data dimensionality
Building blocks
Common language and understanding

Functional Architecture

DATA MANAGEMENT
Long-term storage
Mass storage
Data validation

SYSTEMS GOVERNANCE
Get registering
Self-healing
Alignment with regulations and standards

IF MANAGEMENT SUPERVISION
Network administration
Service administration
Threat monitoring

COMMON COMMUNICATION MEDIA
Emergency & crisis management
Message queuing - services, directory

SHARED

UNIFIED OPERATOR’S UX COMPONENTS
Analyzed power distribution
Network schemas
Supervision / Hypervision component
User training

CENTRAL HUB
Power equipment
Digital infrastructure
Configuration tools
Configurations and settings repository
DQ/PS/Report

ASSET REPOSITORY
Real-time monitoring
Log analytics
Asset performance
Asset maintenance
Asset planning
Asset lifecycle mgmt

ANALYTICS
Health index
System optimization
Digital twin
Predictive analytics
Deep learning
Simulation

LFE High-Level Functional Architecture V1.0 - CC 4.0
Reference architecture PSNO
Robustness, clear, integrated, inclusive

For more background on Edge see this.
Open source

Where we meet

• **Just a handshake for scaling up.**
  • We have already worked in open source for years, however not with a clear structure or strategy. It all got momentum when we met via LFE with RTE and started discussing the functional architecture and the direction of the community.

• **It is all about the transition.**
  • LFE helped us understand the real value of sharing. Because of this we could shape the path forward. It is the mental model!

• **We have to impact society.**
  • Whether it is a 50+% CO2 reduction or facilitating free energy markets, LFE is role agnostic and helps connect.

• **Our worlds are one.**
  • Either TSO or DSO in the area of software or hardware are doing the same functionally. So it is a matter of open understanding how ideas can merge and be enforced by the LFE community at the appropriate abstraction.

• **Open source unless.**
  • We chose to embed LFE in the leadership team, not a constraint to development but a way of working. We chose to position the OSPO in the business. We believe it is about the value of use cases over software.
OPEN SOURCE AT ENERGINET

The journey, considerations and initiatives

October 2021
AGENDA

• Energinet and open source
• Why open source at Energinet?
• Increasing the maturity level: The start of a journey
• Open source as part of a digitalisation effort
• Open source work in progress and next steps
• Questions or comments
Jesper Abildgaard Nielsen
Senior Director, Data & Systems at Energinet
ENERGINET AND OPEN SOURCE

• An independent public enterprise owned by the Danish Ministry of Climate, Energy and Utilities.
• We own, operate and develop the transmission systems for electricity and natural gas in Denmark.
• Approximately 1,500 employees
• Green Energy for a Better World: every day, we work with designing, maintaining, developing and expanding energy systems that will make it possible to use renewable energy for everything - In Denmark and globally.

• Open source strategy developed in early 2020.
• Vision: More efficient development of software through collaboration and innovation.
• Four strategic key elements:
  ➢ Open Source - an early professional assessment
  ➢ Open Source – a strategic outside-in approach
  ➢ Open Source – a competence in Energinet
  ➢ Open Source – a part of the culture
WHY OPEN SOURCE AT ENERGINET?

• TSOs similar to Energinet are increasingly tapping into international open source communities
• Increased demand for development and innovation competencies
• Greater value creation when developing solutions across competencies and borders
• A great platform for collaboration and co-creation, thinking differently and continuous learning
INCREASING THE MATURITY LEVEL: THE START OF A JOURNEY

- Consuming open source, but not on strategic level yet
- Learning by doing – first ”high-stakes” project the new DataHub 3.0.
- Just starting to understand about community building
- Engaging with our surroundings, sharing insights and learning internally and externally is key.
- Open source understanding at management level, but still work to be done.
OPEN SOURCE AS PART OF A DIGITALISATION EFFORT

Targeting from two angles:

1. Political and strategic: Trying to influence the development of the Danish national digitalisation strategy development (among others) to look towards an open source first approach.

2. Trying to implement an “Open source first” principle across the organisation in connection with both consumption and new development.

Experiences:

- Open source from the beginning makes it easier to establish a great culture and sufficient documentation of the project (converting is expensive and time-consuming)
OPEN SOURCE WORK IN PROGRESS AND NEXT STEPS

Developments in the Grid Operations area:
- Short-term forecasting (Alliander dialogue on contribution and collaboration)
- Situational analysis
- Dynamic stability tool (RTE)

Marketing and engagement with other TSOs, technology leaders as well as LF Energy on knowledge sharing, collaboration and community building

Considerations on establishing the right level of support across the organisation (OSPO)
QUESTIONS OR COMMENTS?
Role of open source in the research environment

Prof. A. Monti
Open Source Approach

Majority of our products are available as open source at www.fein-aachen.org

Ein Ziel von FEIN Aachen ist die Förderung und Veröffentlichung von Softwareprojekten die im Rahmen der Forschung am Institut ACS entwickelt wurden. Der Verein ist überzeugt, dass diese Forschungsergebnisse Jedermann in Form von Open Source Software zugänglich sein sollte.

Wenn Ihnen unsere Arbeit gefällt und Sie uns unterstützen möchten, kontaktieren Sie uns bitte unter info@fein-aachen.org.

Die folgende Liste ist ein Auszug der am Institut entwickelten Software:
- SOGNO will provide a disruptive approach to grid automation based on virtualization
- Intensive application of deep learning techniques
- 5G based edge computing to support IoT connection
- Main Deliverable: fully Virtualized Substation (VISA)
The project Service-based Open-source Grid automation platform for Network Operation of the future (SOGNO) is creating plug-and-play, cloud-native, micro-services to implement our next generation of data-driven monitoring and control systems. It will simplify the life of distribution utilities by enabling them to optimize their network operations through open source to deliver cost-effectively, and seamless, secure power supply for their customers. SOGNO introduces the idea of grid automation as a modular system in which components can be added through time. This is in opposition to classical monolithic solutions.

SOGNO is maturing data-driven control services. The architecture is independent of the communication media but it has been designed originally to have 5G in mind and its edge cloud approach. By using the upcoming 5G mobile network standard they will be characterized by low latency and high availability.

Power system networks of the future will be composed of architectures profiles for the relationship between loads, resources, and the ability...
ERIGrid 2.0 – Connecting European Smart Grid Infrastructures
VILLASframework

- Open source tool kit for distributed real-time simulation (GPLv3 license)

VILLASnode
  - A gateway for real-time simulation data

VILLASweb
  - A web-interface for planning, executing and controlling distributed simulations

DPsim
  - A real-time simulation kernel for the EMT/DP domain

CIM++
  - A library for parsing and compiling CIM to Modelica, GLM

Pintura
  - Web-based Graphical Editor for CIM models
Tools enabling real-time simulation for teaching

- Web frontend as graphical user interface for students
- Analytical processing of experimental data within Notebooks for students
- VILLASweb
  - Visualization (Topology + RT-Data)
  - Simulator Control
  - Data Management
- DPsim
  - Real-time simulation
- Jupyter
  - Extraction of data
  - Postprocessing
VILLASweb – Experiment visualization

Case 1: Electromagnetic Phenomena of Synchronous Machines

Characteristics:
- Single machine with bus system
- Full load on synchronous generator model

Case 2: Electromechanical Phenomena of Synchronous Machines

SLEW Grid - The Virtual Playground
Conclusions

- Open Source is an obvious approach for academics

- Research is based on cooperation and communities exactly like the open source world

- It used to be for us “simply” a way to cooperate among academics, it is now driving the way we work with industry
Kontakt

E.ON Energy Research Center
Mathieustraße 10
52074 Aachen
Germany