

LVK Climate & Sustainability Committee

Daniela Pascucci
for the LVK Climate & Sustainability Committee

Meeting of the *Groupe Environnement* of the GdR ondes gravitationnelles
Paris - 19th February 2026



A joint LVK committee

LSC

The Climate & Sustainability Committee was officially formalised and added in the Bylaws in August 2024.

Virgo

The Climate and Sustainability Committee was officially formalised and added in the Bylaws in January 2025.

KAGRA

The Climate Change Working Group has been recognised since its birth in October 2019 as a joint LVK working group.

LIGO Chair: Elise Sanger

Virgo Chair: Daniela Pascucci

KAGRA Chair: Lan Nguyen Quynh

Working as a joint committee with common projects and meetings.

White Paper

A White Paper was released on March 2024.

*“The mission of the Climate & Sustainability Committee is to help the LVK collaborations and their members to take action on climate change and sustainability. The goals of the committee are twofold. The main goal is **to evaluate and reduce the climate impact of the LVK and its activities**. The other goal is **to educate LVK members as well as the outside community about climate change and what they can do to reduce their climate impact.**”*

Climate Committee White Paper: <https://dcc.ligo.org/T2400084> [access only to LVK members]

White Paper: activities

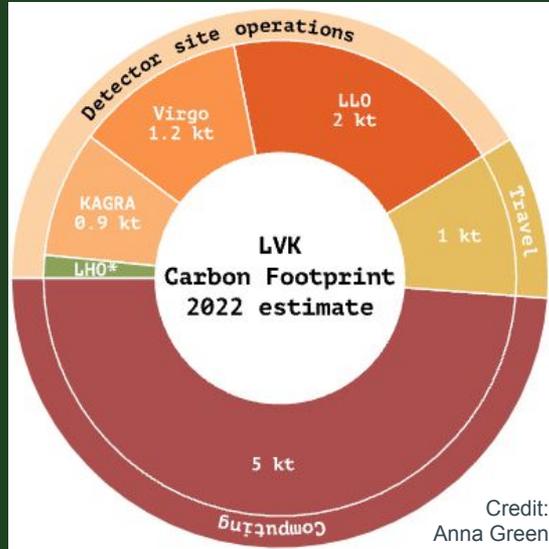
Activities included in the White Paper:

- Evaluate and track the LVK's climate impact
- Reduce LVK's climate impact
- Build awareness of climate change, both within and outside of the LVK
- Report on the LVK's climate impact

Climate Committee White Paper: <https://dcc.ligo.org/T2400084> [access only to LVK members]

LVK carbon footprint estimate

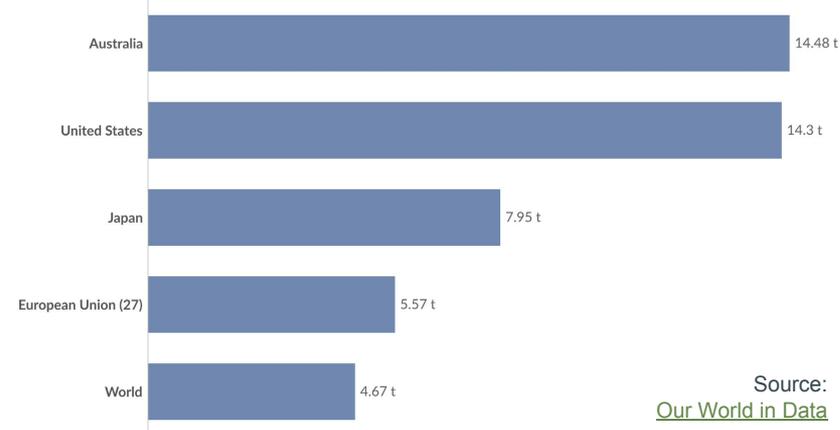
- Total: 10,000 tonnes CO₂ per year
- LVK "per capita" contribution: ~5 tonnes/person/year (world average: 4.7)
- LHO's carbon footprint is much lower due to using primarily hydroelectric energy



CO₂ emissions per capita, 2023

Carbon dioxide (CO₂) emissions from burning fossil fuels and industrial processes¹. This includes emissions from transport, electricity generation, and heating, but not land-use change².

Our World in Data



Recommendations to consider

- Detectors
 - Install solar panels at the detector sites
- Meetings
 - Reduce the number of international collaboration meetings & increase usage of virtual meetings
 - Use the time around the LVK meetings for satellite/other f2f meetings to reduce number of trips
 - Choose meeting locations to minimize distance travelled
 - Minimize waste/single use items
 - Only serve vegetarian food
- Computing
 - Reduce computing and increase computing efficiency
 - Switch computing centers to renewable power
 - Benchmark codes for efficiency
 - Report on carbon footprint of analyses for (collaboration) papers
 - Have our accounting system also display carbon footprint of jobs
 - Have OSG jobs prefer sustainable clusters
- Education of LVK members about climate issues
 - Plenary talk at LVK meeting
- Engage with other collaborations to share knowledge and experience

Projects

Current projects include:

- Climate Change Conversations
- Carbon footprint of computing
- Recommendations for meetings
- Survey within LVK about climate
- Travel footprint tracking
- Solar panels at LIGO Livingston
- Funding for climate activities
- Webpage on LIGO website
- Prize for climate activities
- Use of LVK data/instruments to help climate science
- Reading list

Activities outside the LVK community:

- Action in home communities; think globally, act locally (get involved in heat pump conversion, electric leaf blowers, etc.)
- Advocacy from LVK members to their government representatives at all levels

Projects

Current projects include:

- Climate Change Conversations
- Carbon footprint of computing
- Recommendations for meetings
- Survey within LVK about climate
- Travel footprint tracking
- Solar panels at LIGO Livingston
- Funding for climate activities
- Webpage on LIGO website
- Prize for climate activities
- Use of LVK data/instruments to help climate science
- Reading list

Activities outside the LVK community:

- Action in home communities; think globally, act locally (get involved in heat pump conversion, electric leaf blowers, etc.)
- Advocacy from LVK members to their government representatives at all levels

Climate Change Conversations

Climate Change Conversations

In collaboration with the LIGO Magazine, a regular article series focused on highlighting climate issues.



A Path to Fossil-free Supercomputing

Tom The most energy-intensive part of LIGO-Virgo-KAGRA work is computing. We perform signal searches, parameter estimation, numerical simulations, and many other computations to enable other collaborations to make the most of their data. To cut the carbon footprint of computing, one can switch their electricity for renewable energy sources.

How hard is it? In this interview, Tom Markin talks to Pekka Manninen from LIGO, which runs on supercomputing in Finland completely on renewable electricity, to find out for an interview with LIGO Magazine. Can you give us a couple of words about LIGO and highlight some of the work-loads that are running on IT?

Pekka Manninen I'm the Director of Science and Technology at OSC, the Finnish Supercomputing Center, where we specialize in high-performance computing. He is also Adjunct Professor at the University of Helsinki.

Tom Computer in Finland completely on renewable electricity, to find out for an interview with LIGO Magazine. Can you give us a couple of words about LIGO and highlight some of the work-loads that are running on IT?

Pekka Manninen LIGO is one of the fastest supercomputers in the world, and until very recently, the fastest in Europe. We installed LIGO over five years ago, and we installed building a faster army of machines to handle anything that scientists have to do. We have a very large spectrum of scientific disciplines using LIGO with various disciplines: climate research, astrophysics, particle and plasma physics, analytic and quantum chromodynamics. Now uses the digital humanities and digital social sciences, and training for language models.

One of LIGO's main features is its use of 100% renewable energy. How do you think about this?



Climate & Sustainability Committee

Tom It is my great pleasure to announce the formation of the Sustainability Committee. We began in 2018 as an ad-hoc committee with discussions on reducing our carbon footprint. This group is now a standing committee within the LIGO Scientific Collaboration's governance structure.

Tom How do you think about this?

Elise Stanger I'm a PhD student working on building a quantum network for the LIGO-Virgo-KAGRA LVCs. I'm also a member of the Sustainability Committee. We have a very large spectrum of scientific disciplines using LIGO with various disciplines: climate research, astrophysics, particle and plasma physics, analytic and quantum chromodynamics. Now uses the digital humanities and digital social sciences, and training for language models.

One of LIGO's main features is its use of 100% renewable energy. How do you think about this?

Tom How do you think about this?

Elise Stanger I'm a PhD student working on building a quantum network for the LIGO-Virgo-KAGRA LVCs. I'm also a member of the Sustainability Committee. We have a very large spectrum of scientific disciplines using LIGO with various disciplines: climate research, astrophysics, particle and plasma physics, analytic and quantum chromodynamics. Now uses the digital humanities and digital social sciences, and training for language models.



Interview with Peter Kalmus

Tom Welcome to Climate Change Conversations, a new article series exploring climate topics. In the first of this series, David Lan Hyogen and Lisa Baum, members of the LIGO-Virgo-KAGRA LVC Committee on Climate Change, interview Victoria Grinberg. We discuss the role of collaborations in tackling climate change, and talk about how all scientists can contribute to climate communication for Planet Earth.

Victoria Grinberg I'm a climate scientist at MIT's Program in Atmospheres, Oceans and Space. I'm also a member of the LIGO-Virgo-KAGRA LVC Committee on Climate Change. We have a very large spectrum of scientific disciplines using LIGO with various disciplines: climate research, astrophysics, particle and plasma physics, analytic and quantum chromodynamics. Now uses the digital humanities and digital social sciences, and training for language models.



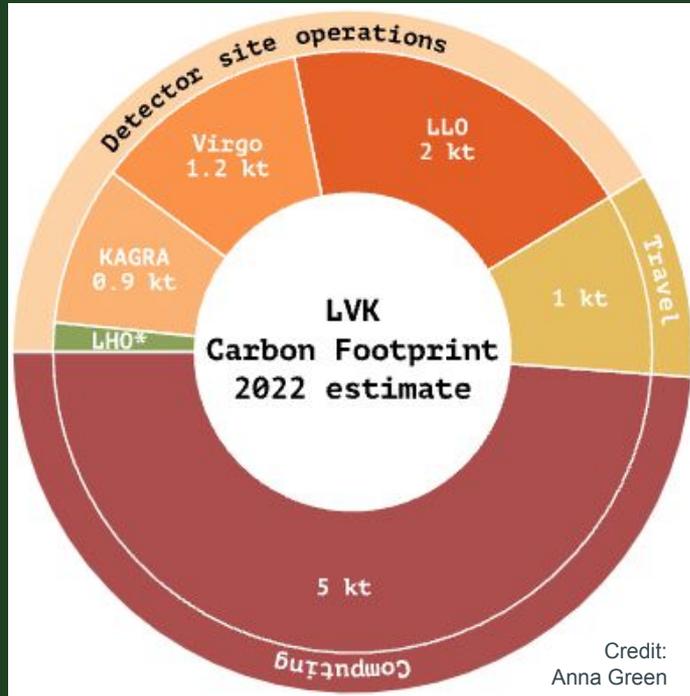
Interview with Victoria Grinberg

Tom Welcome to Climate Change Conversations, a new article series exploring climate topics. In the first of this series, David Lan Hyogen and Lisa Baum, members of the LIGO-Virgo-KAGRA LVC Committee on Climate Change, interview Victoria Grinberg. We discuss the role of collaborations in tackling climate change, and talk about how all scientists can contribute to climate communication for Planet Earth.

Victoria Grinberg I'm a climate scientist at MIT's Program in Atmospheres, Oceans and Space. I'm also a member of the LIGO-Virgo-KAGRA LVC Committee on Climate Change. We have a very large spectrum of scientific disciplines using LIGO with various disciplines: climate research, astrophysics, particle and plasma physics, analytic and quantum chromodynamics. Now uses the digital humanities and digital social sciences, and training for language models.

Carbon footprint from computing

LVK carbon footprint from computing



Almost half of the emissions from LVK activities comes from computing

Carbon footprint from computing

Depends on

- Type of CPU / GPU: thermal design power
- Computing time (core hours)
- Memory used
- Power source / location of cluster

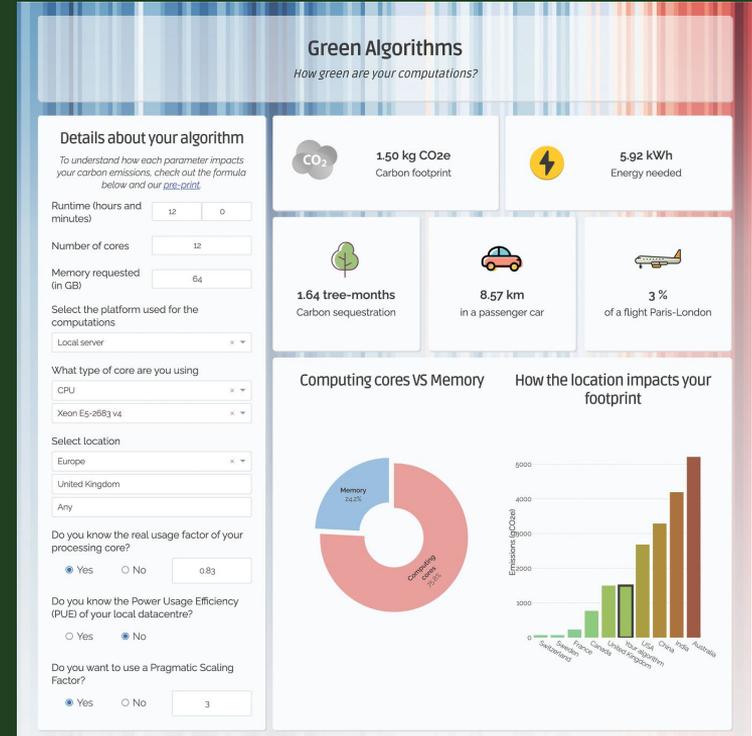
Green Algorithms calculator:

<https://calculator.green-algorithms.org/>

CPU usage / emission tool (Credit: Ivan Markin):

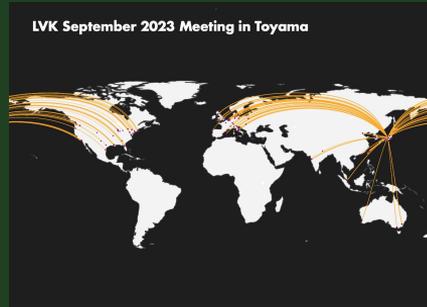
<https://github.com/unkaktus/calcium>

(see also Appendix E of arXiv:2304.11642
and Appendix C of arXiv:2508.08750)

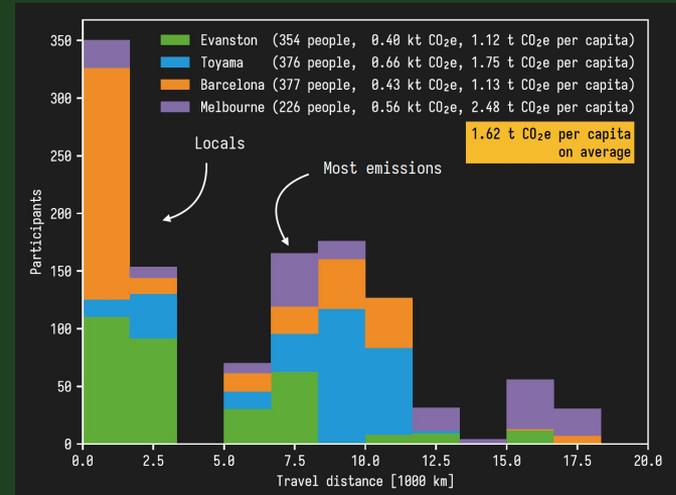


Travel footprint tracking

Travel footprint tracking



Distribution of travel distances



Credit: Ivan Markin - [G2500611](#) [access only to LVK members]

Local hubs

Having a conference split in multiple connected hubs.

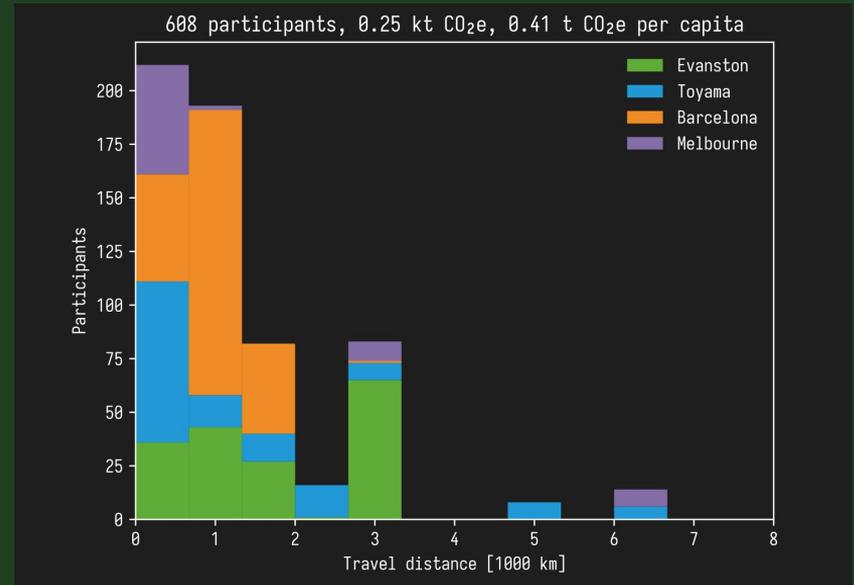
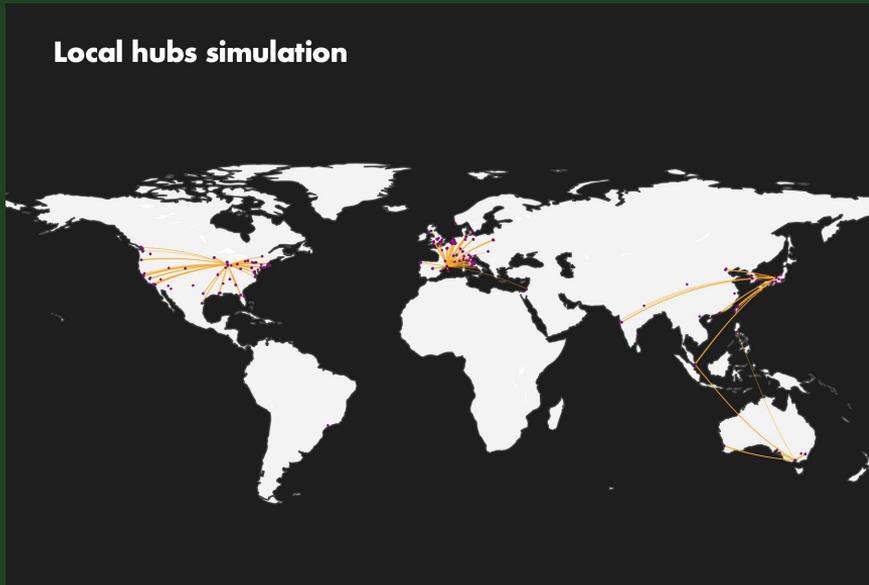
Advantages

- Cut down on long-haul flights
- More participants overall, including the ones for whom travel is less affordable
- More chances for public transport
- Less jetlag and more healthy sleep schedule

Challenges

- People want to mingle in person
- Multi-time zone scheduling and coordination
- Costs of having multiple sites
- Stable Internet and equipment

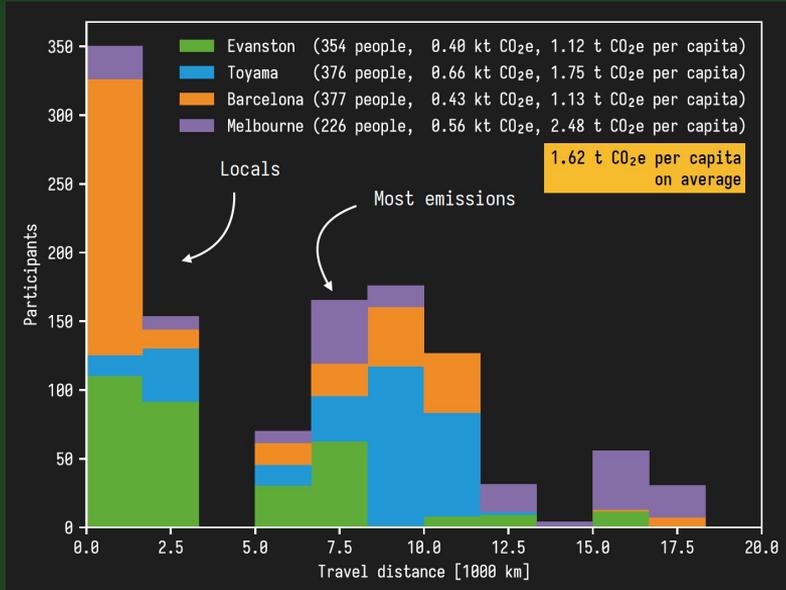
Local hubs simulations



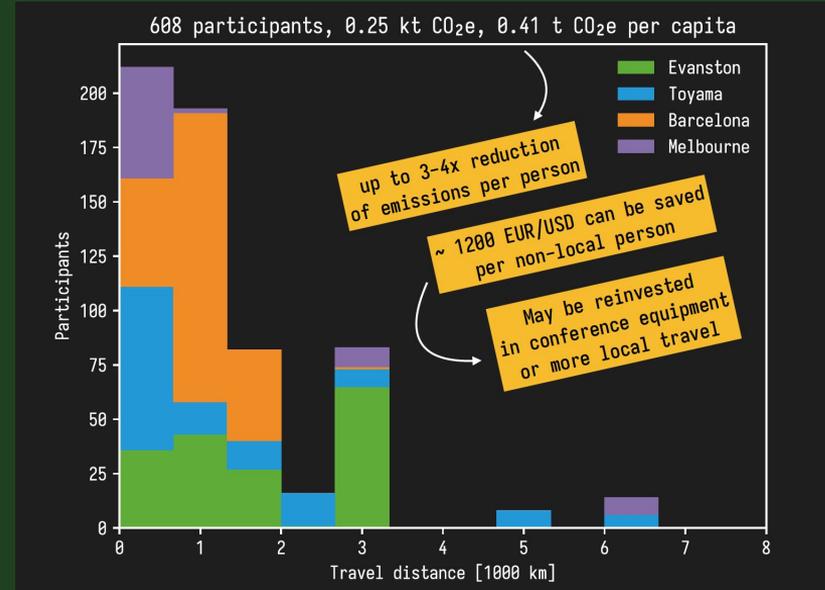
Credit: Ivan Markin - [G2500611](#) [access only to LVK members]

Travel footprint comparison

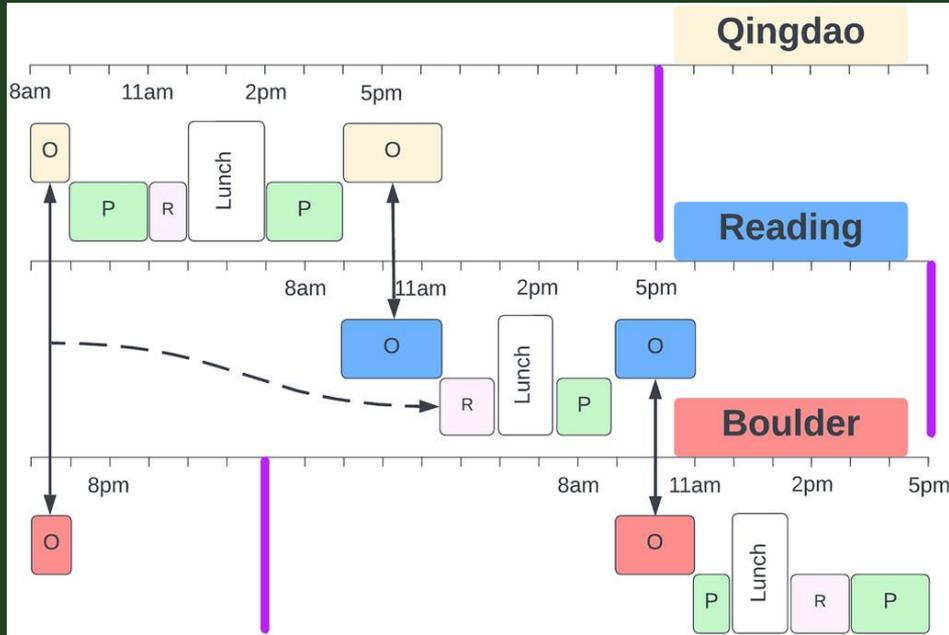
Distribution of travel distances



Local hubs simulation



Local hubs — Real-world example



3 hubs → Qingdao (China), Reading (UK), and Boulder (USA)

Purple vertical lines → end of a local 24-h period

O → oral sessions

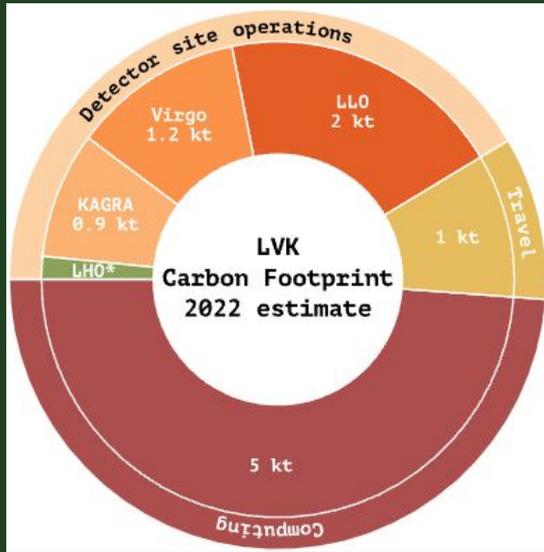
P → poster sessions

R → playing recorded talks, which took place while the hub was asleep

Adapted from Bulletin of the American Meteorological Society 105, 1 10.1175/BAMS-D-23-0160.1

Solar panels at LIGO Livingston

Carbon footprint from detector operations



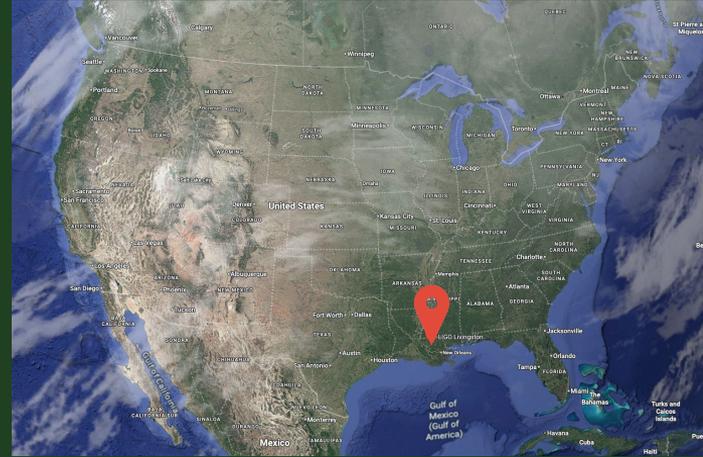
LIGO Hanford (LHO) carbon footprint is much lower due to using primarily hydroelectric energy

idea

Can we make LIGO Livingston (LLO) carbon neutral?

LIGO Livingston (LLO)

LLO is the LIGO detector located in Livingston (LA), USA



Can we make LLO carbon neutral?



Idea to install solar panels above the arms
of the interferometer



Total area 16,000 m²

Can we make LLO carbon neutral?

Very rough estimate:

LLO two-arm area = 16000.0 m²

Solar panels at LLO will produce 7.2 GWh annually

LLO consumes 7.0 GWh yearly

With solar panels LLO will produce 1.0x of its usage

LLO electricity costs 0.8 M\$ annually

6400 modules would cost 0.7 M\$

The PV system would cost 1.3 M\$

--> The PV system will break even in 1.7 years with self-consumption only

LLO surplus annual income: 0.0 M\$

LLO production annual income without self-consumption: 0.2 M\$

--> The PV system will break even in 1.7 years with self-consumption and surplus income

--> The PV system will break even in 7.0 years with no self-consumption

Engage with other collaborations

Engage with other collaborations

- We think it is important to engage with other big facilities to share knowledge, experiences and strategies (especially with facilities not yet built, like ET)
- We already had a chat with the Sustainability Lead for the Cherenkov Telescope Array Observatory, who is considering the idea to start a forum/working group focused on sustainability across large astronomical facilities
- Please get in touch if you're interested in participating (daniela.pascucci@ugent.be)

Relevant literature

- Overview and data of aviation emissions:
<https://ourworldindata.org/global-aviation-emissions>
- The paper with reference values for the aviation emissions:
<https://www.nature.com/articles/s41893-022-01046-9>
- A case study for online-first meeting, with successes and shortcomings:
<https://www.nature.com/articles/s41550-024-02460-z>
- Testing of local hub approach for a climate science conference:
<https://journals.ametsoc.org/view/journals/bams/105/1/BAMS-D-23-0160.1.xml>

Thanks a lot for your attention