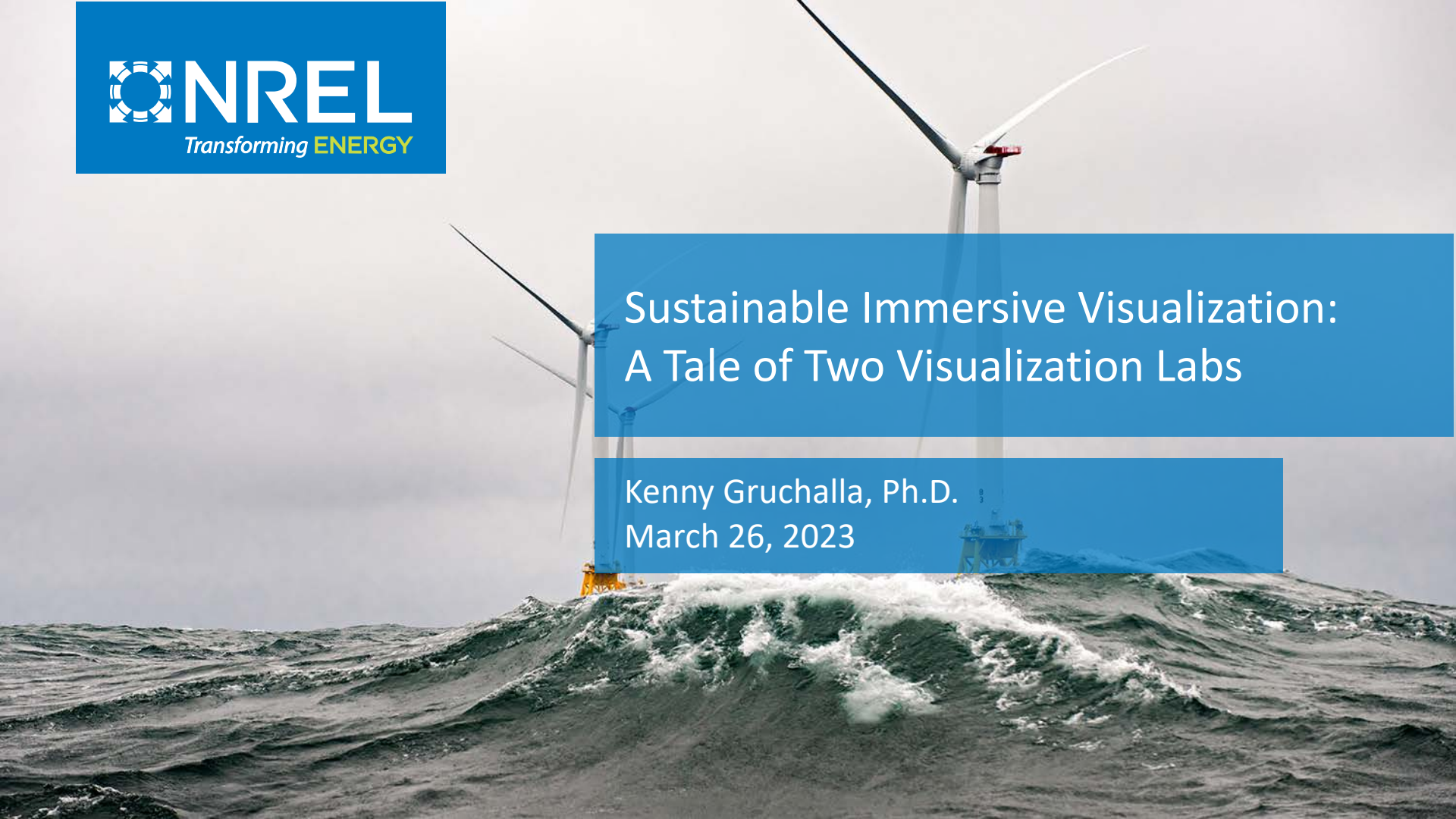


NREL
Transforming ENERGY

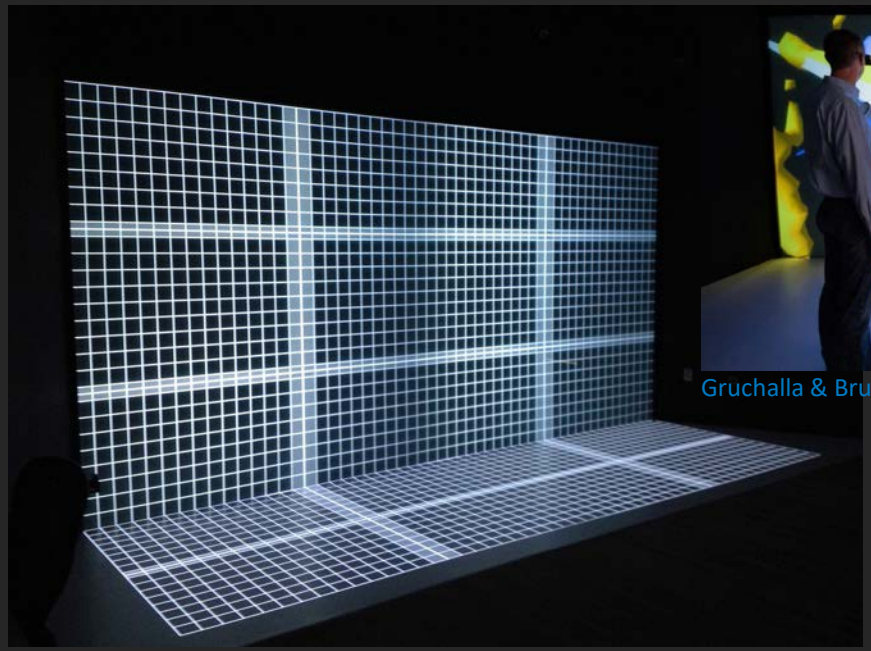
Sustainable Immersive Visualization: A Tale of Two Visualization Labs

Kenny Gruchalla, Ph.D.
March 26, 2023

Insight Center Mission

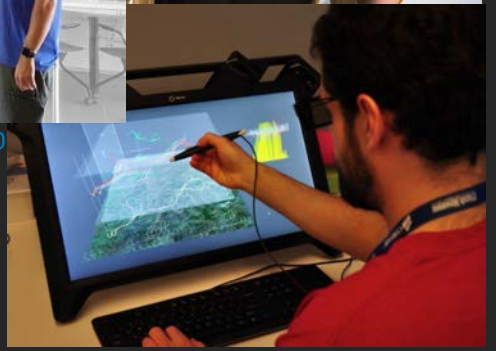
Combine state-of-the-art visualization and human-computer interaction techniques and tools to promote knowledge discovery for energy systems, providing cross-cutting qualitative and quantitative analysis for all NREL programs and partners.

Immersive Capabilities



Gruchalla & Brunhart-Lupo 2019

Whitlock, et al. 2020



2-surface 6-projector (16ft x 8fx x 6ft)

- Active Stereo (Christie Mirage)
- Optical Tracking (Vicon)
- Blended (Christie Twist)

Linux-based

Software Environment

Custom C++/OpenGL

Immersive ParaView

Unity3D

Avizo

FreeVR-VMD

Software Environment

Custom C+

Re-evaluating:

- Our Custom SceneGraph
- Unity3D
- Unreal Engine

Immersive ParaView

Unity3D

Avizo

FreeVR-VMD

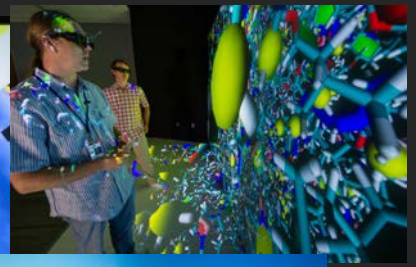
The Immersive Visualization Road*

* is lined with the corpses of immersive visualization laboratories

Gruchalla, et al. 2008

Gruchalla 2004

Gruchalla & Marbach 2004



Gruchalla & Brunhart-Lupo 2019

BP Center Opens

BP Center Closes

ESIF design-build begins

Insight Center Opens

Insight Center Refresh

University of Colorado Boulder

2001

BP Center for Visualization

2005

2009

2012

NREL Transforming ENERGY

Insight Center

2023

Insight Center – Recipe for Success

Funding

- Need the right model

Demonstrating Added Value

- Science & Engineering
- Fundraising & Outreach

Avoiding Misuse

Brunhart-Lupo, et al. 2016

Funding Model

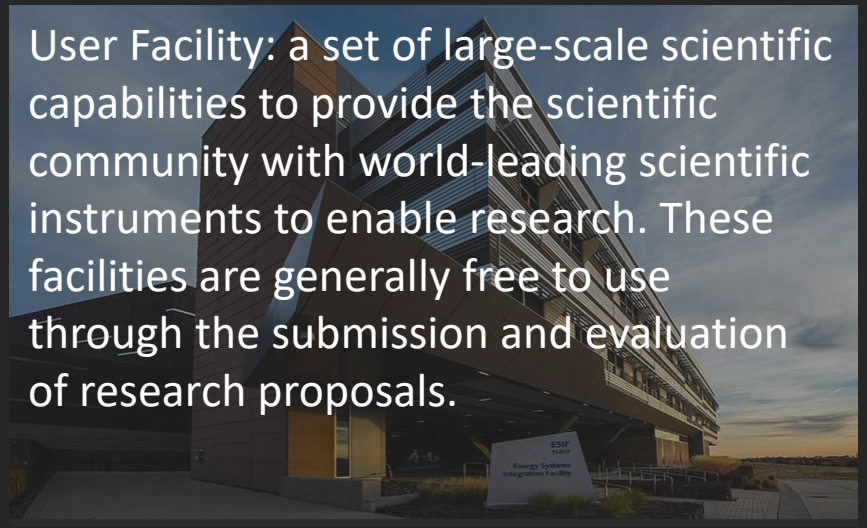
CU - Failure:

- Cost Service Center Funding
  - Projects pay hourly
    - existing projects did not anticipate the budget
    - Proposed project often found it incompatible with funding agencies

A service center is an operating unit that provides goods or services to university departments and recovers annual operating expenses through direct charges to those departments and entities receiving the goods or services.

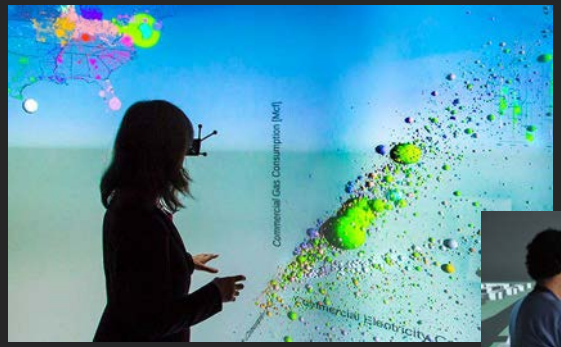
NREL - Success:

- User Facility Funding
  - No charge for project usage*
    - Small amount of staff time (< 1 FTE)
    - Annual maintenance budget

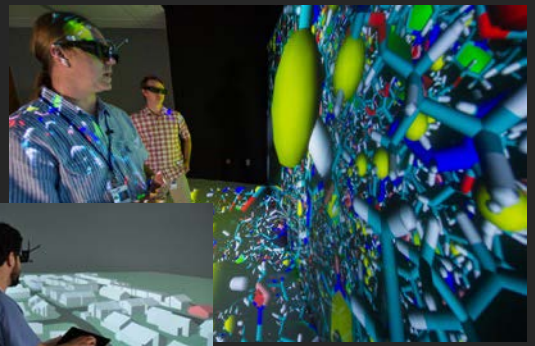


User Facility: a set of large-scale scientific capabilities to provide the scientific community with world-leading scientific instruments to enable research. These facilities are generally free to use through the submission and evaluation of research proposals.

USING THE IMMERSIVE SPACE



Brunhart-Lupo, et al. 2020



Macumber, et al. 2016

Podder, et al. 2022

Easy
(no task # needed)

Involved
(bring funding)

Direct Data Import:
- nD point clouds (x,y,z,…)
- 3D objects / isosurfaces
- ParaView scenes
- Unity Apps

Established Workflows:
- VMD Scenes
- Distribution Power Flow
- CFD
- R/Python interaction

Custom Design/Development:
- C++/OpenGL/Qt Apps
- Novel Visualization
- Novel Interaction Devices

Immersive Visualization Value

Improved Spatial Judgments

Direct 3D Interaction

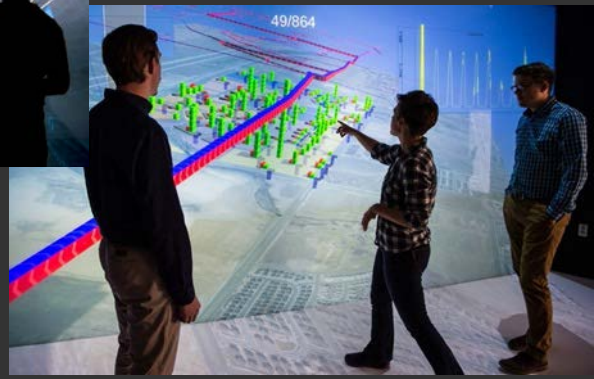
High-Dimensional Data

Collaboration

Gruchalla & Brunhart-Lupo, 2019

Brunhart-Lupo & Gruchalla, 2023

Brunhart-Lupo, et al. 2016



Bush, et al. 2017

Workflow Augmentation

All of our big successes have resulted from small augmentations to traditional workflows (not the replacement of them).

A better qualitative understanding leading to quantitative changes in:

- Model design
- Model validation
- Data analysis

Bugbee, et al. 2019

Next Steps

Coming this Year!

6 x Christie HD6K → 6 x Christie 304K

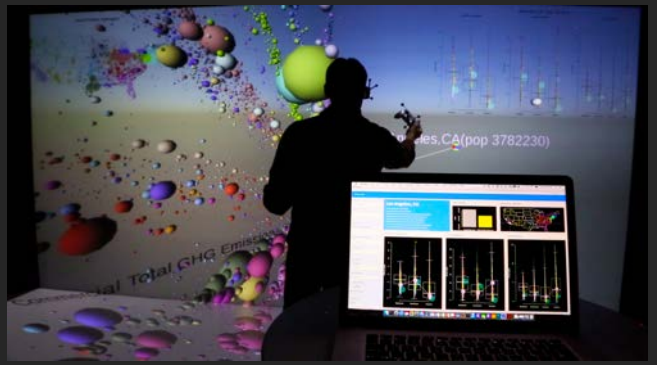
4X Increase in resolution 10MP → 40MP
2X Increase in speed 120Hz → 240Hz

Re-evaluating:

- Our Custom SceneGraph
- Unity3D
- Unreal Engine

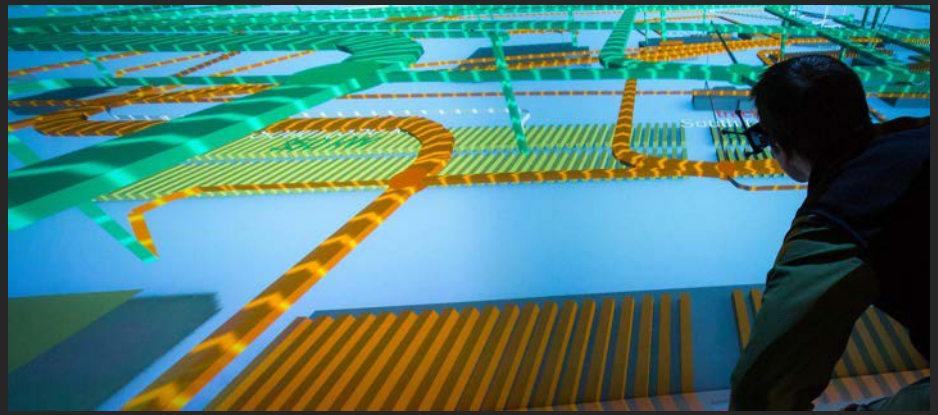
Trying to develop better usage metrics

Heterogeneous Collaborative Visualization



Brunhart-Lupo, et al. 2020

ACKNOWLEDGMENTS



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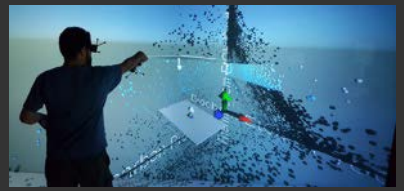
PUBLICATIONS



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