

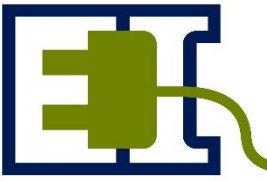
ENERGY

data analytics

Kyle Bradbury



Overview



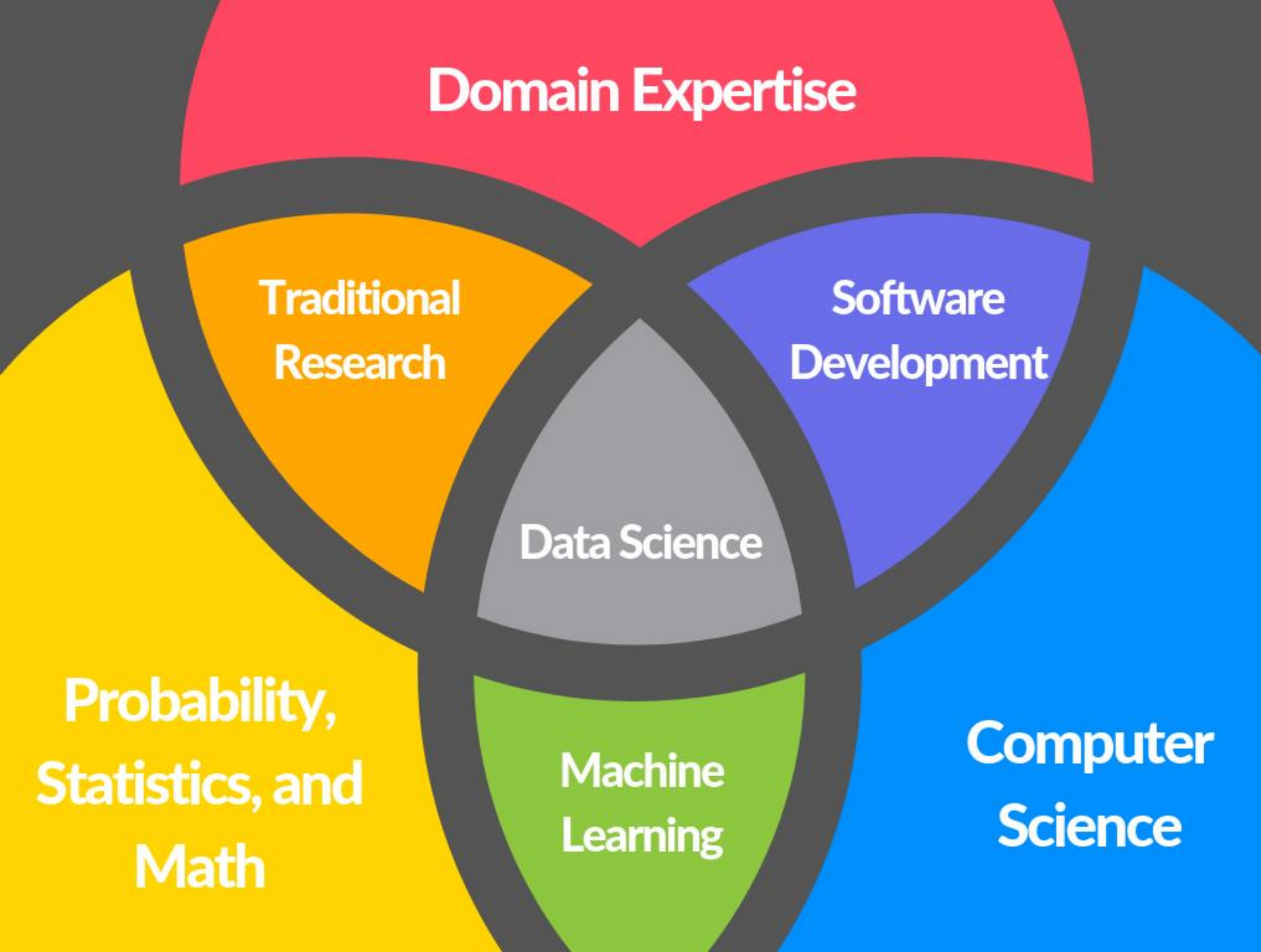
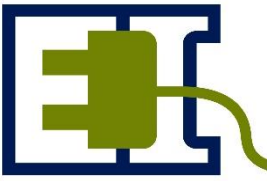
World's shortest **explanation of data science**

Energy **data** increases

Data science energy **applications**

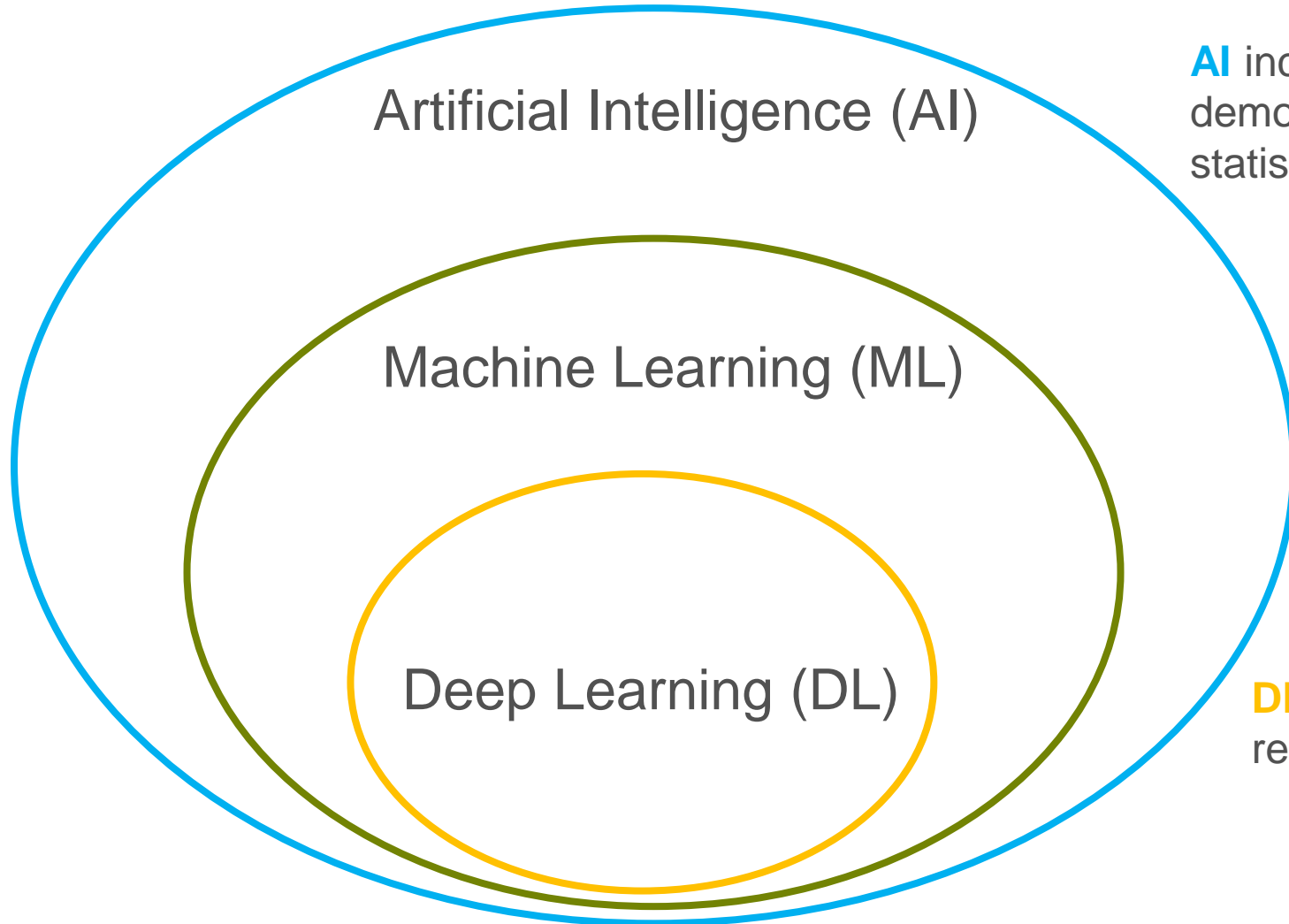
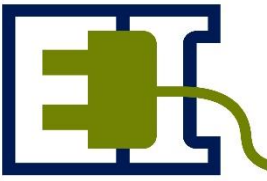
Energy data science **challenges**

Duke's Energy Data Analytics Lab and **how to get involved**



Data science is the **fusion** of many disciplines

Hierarchy of Learning



AI includes many types of intelligence demonstrated by machines: cybernetics, symbolic, statistical learning

ML can...

Uncover structure in data (unsupervised)

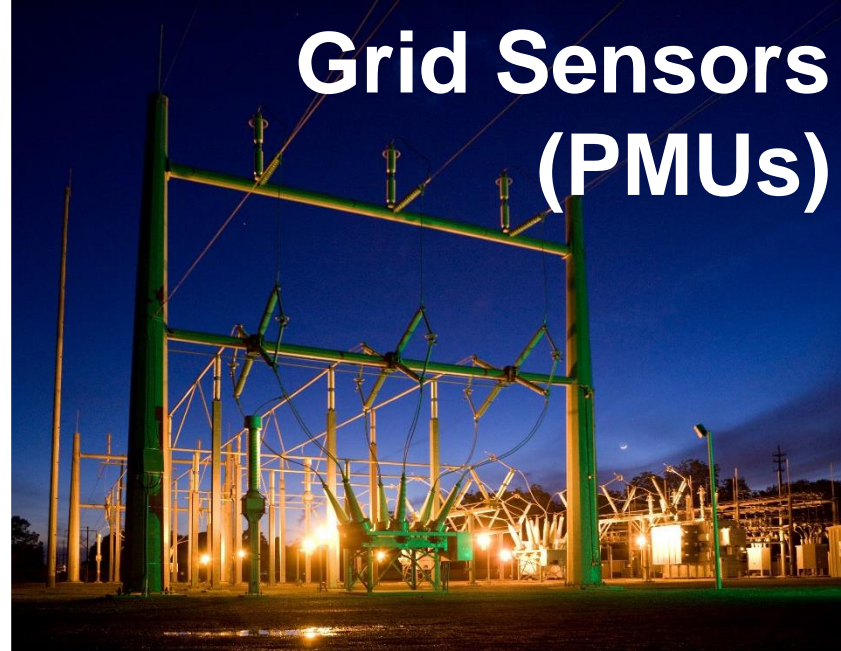
Make predictions (supervised)

Learn by doing (reinforcement)

DL is a type of **ML** that makes use of recent advances in computation



Smart meters



Grid Sensors (PMUs)



Smart appliances

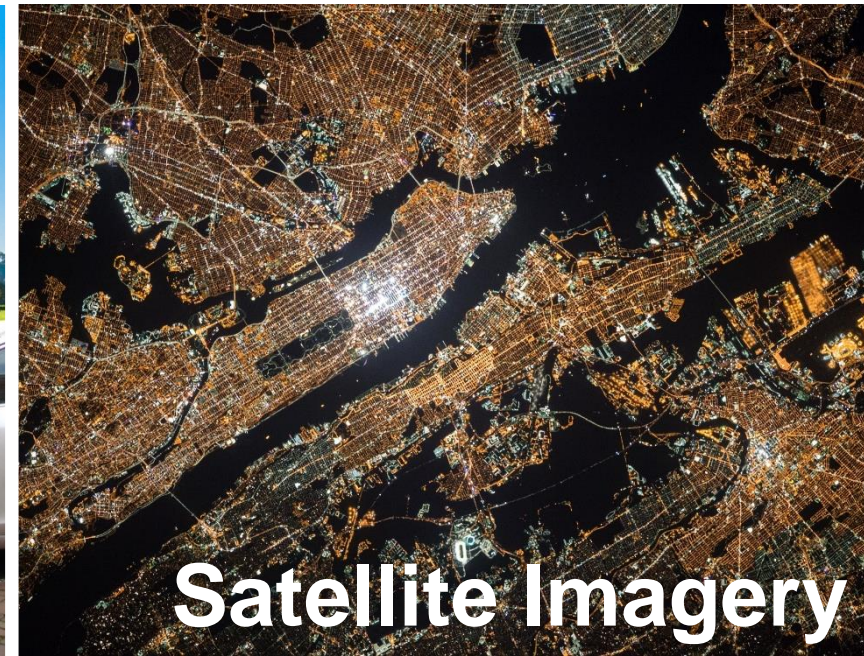
Sources of energy data



Power Markets

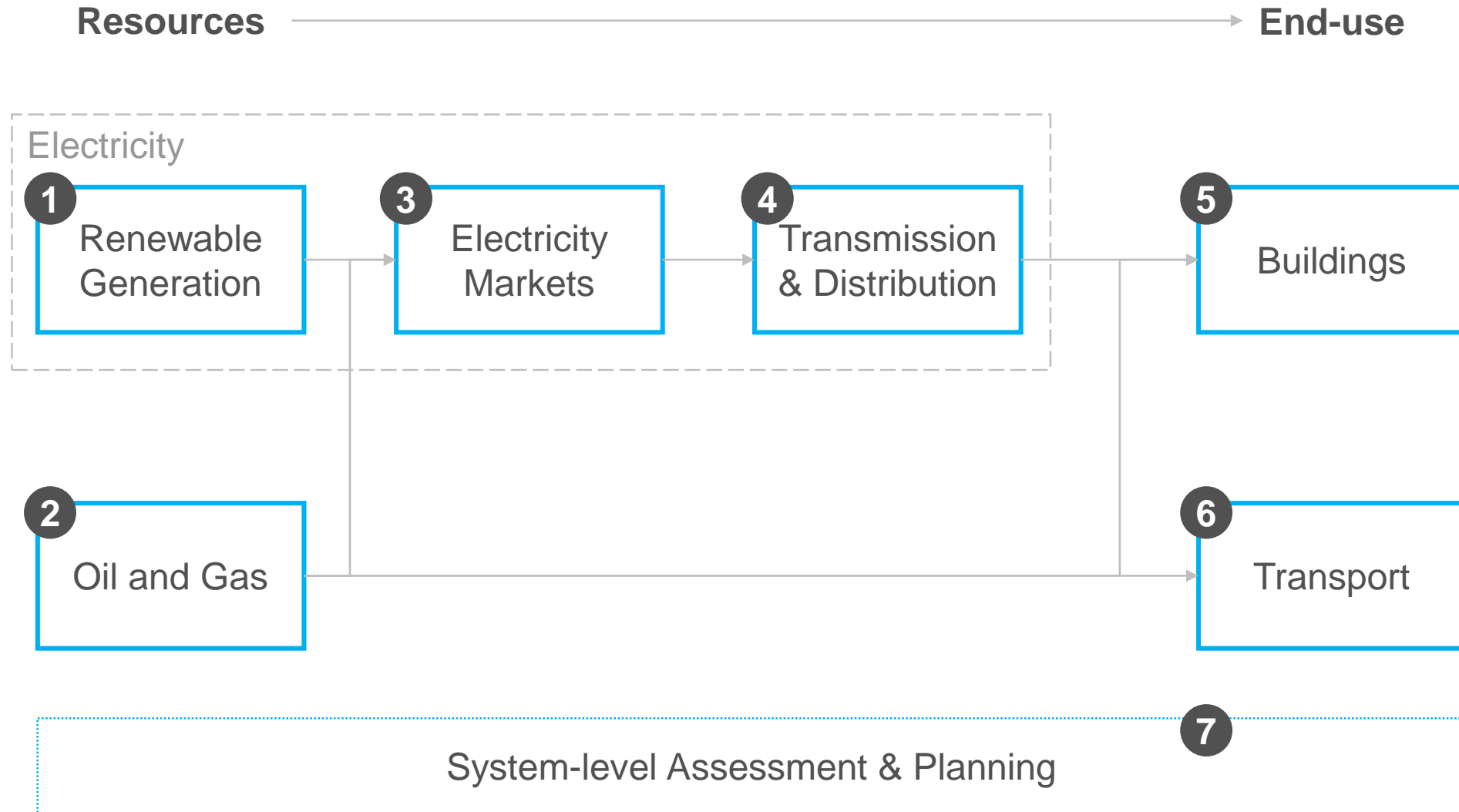
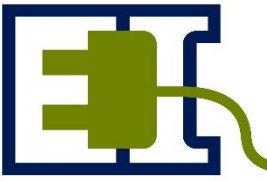


Vehicles



Satellite Imagery

Roadmap: Key Energy Data Analytics Application Areas



1 Renewable Generation

Generation Prediction & Forecasting

(e.g. IBM, The Weather Company, and Deep Thunder)

Optimal Siting

Optimal Sizing

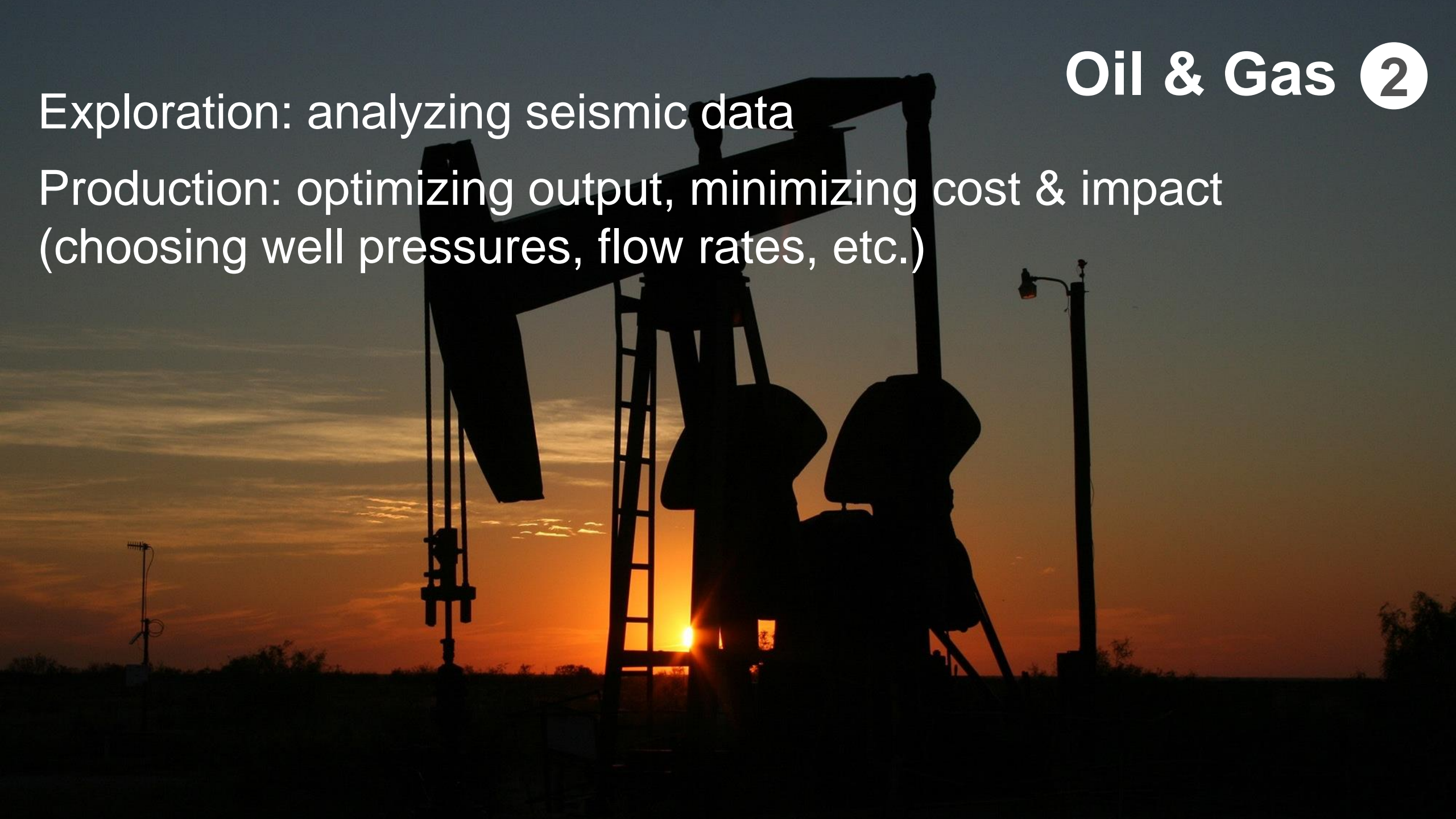
Materials discovery



Oil & Gas ②

Exploration: analyzing seismic data

Production: optimizing output, minimizing cost & impact
(choosing well pressures, flow rates, etc.)



Electricity Markets 3

Forecasting market clearing prices
(and bids)

Demand forecasting

Enabling distributed peer-to-peer transactions
(e.g. blockchain)



④ Transmission & Distribution

Detecting and predicting line faults

Improved reliability through preventative maintenance

Non-technical loss (i.e. theft) detection

Anomaly detection

Internet-of-things devices energy insights

(e.g. decentralized demand response)

Automated demand management

(e.g. peak shifting, arbitrage, demand charge reduction)

Automated building energy auditing

(e.g. non-intrusive load monitoring)

Demand-side management aggregation

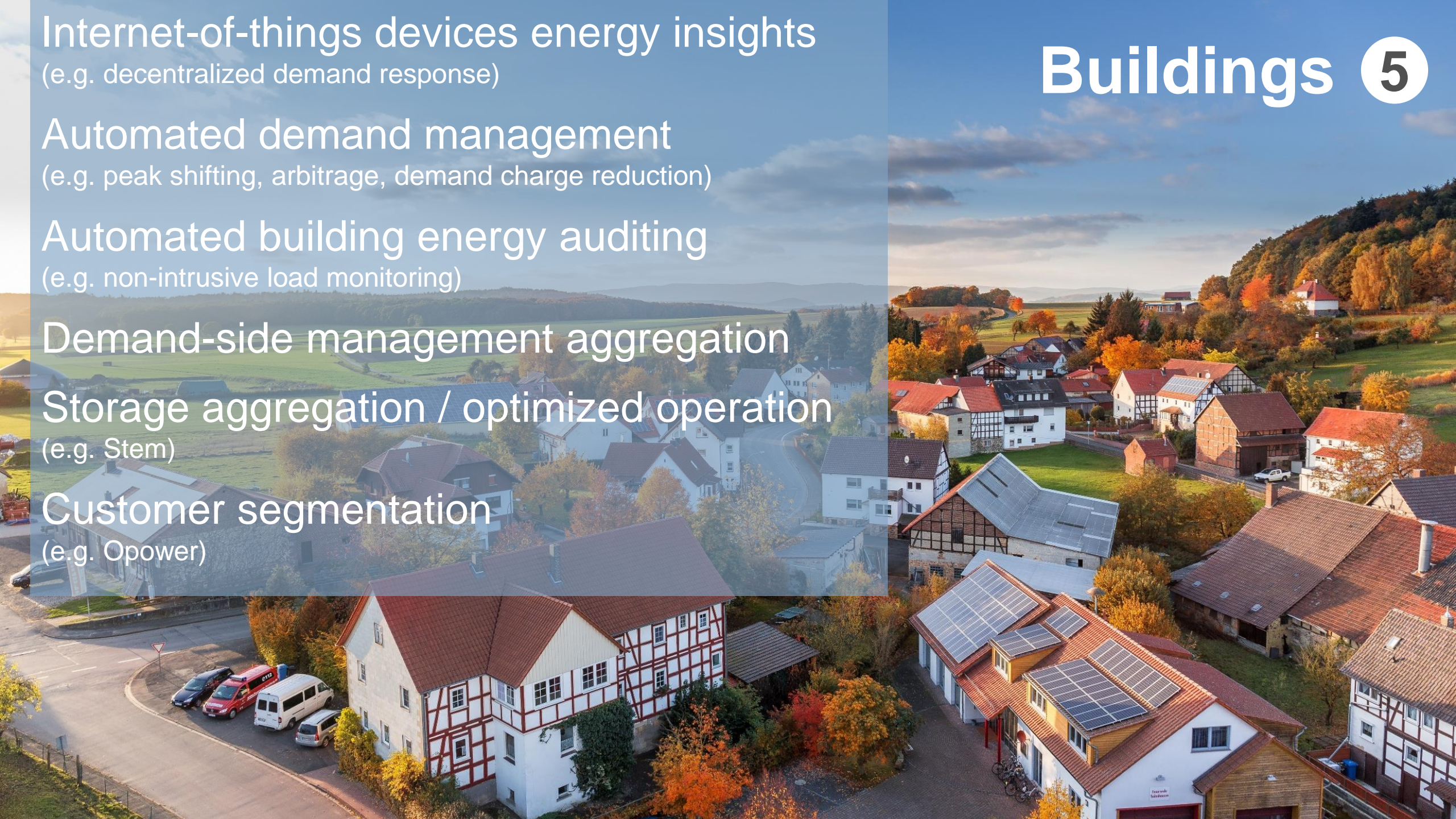
Storage aggregation / optimized operation

(e.g. Stem)

Customer segmentation

(e.g. Opower)

Buildings 5



6 Transport

An aerial photograph of a city street intersection. The image shows multiple lanes of traffic, with cars and a truck visible. Pedestrians are walking on the sidewalks. The scene is captured from a high angle, showing the layout of the roads and the surrounding urban environment.

Infrastructure planning: eliminating bottlenecks, optimizing traffic signals, investment decisions

Improve engine design

(e.g. meeting Corporate Average Fuel Economy, or CAFE, standards)

Autonomous vehicle operation

Electric vehicles as grid resources

An aerial photograph of a coastal town. The top left shows a sandy beach meeting turquoise water. The town is built on a hillside, with many houses having red roofs. A road winds through the town. The bottom right shows a large green field.

7

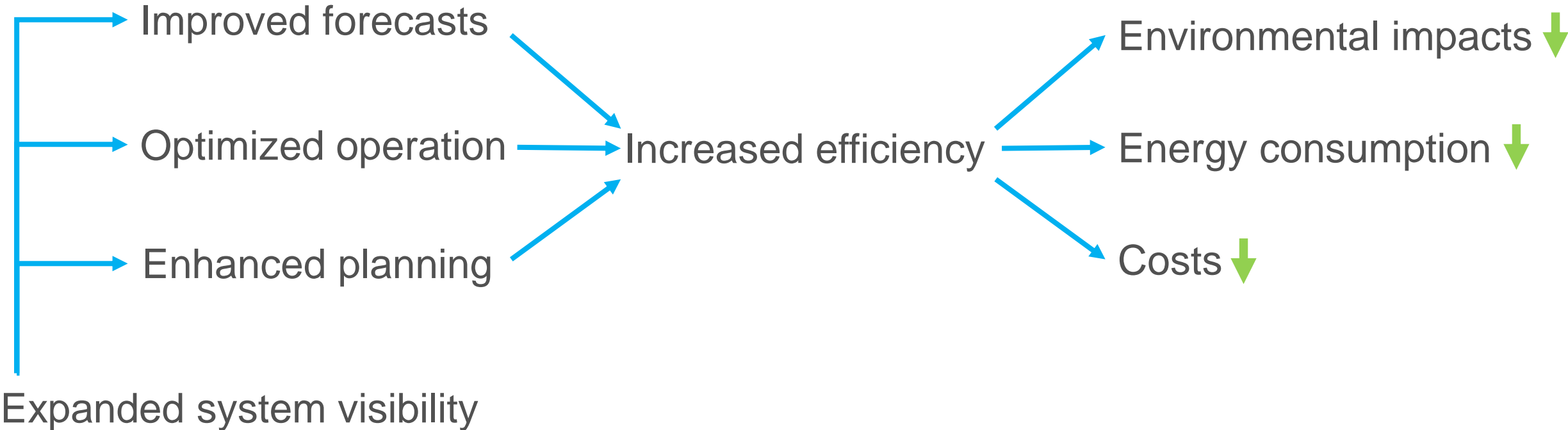
System-level Assessment & Planning

Assessing installed generation
capacity

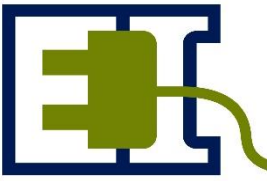
Predicting future distributed
generation installation

Monitoring global oil supply
(e.g. Orbital Insight)

Mapping applications into benefits



Challenges



Privacy

Data Availability



Possibility of determining...

...activities in a building

...presence at home

Some databases contain personally identifiable information

Data unavailability limits...

...innovation

...system understanding & insight

Data are often proprietary or restricted



Human Behavior



Energy Markets & Policies



Smart Devices & Sensors



Transport

Electricity



Industry



Buildings

ENERGY SYSTEMS

DATA

- Open source
- Proprietary commercial
- Confidential government
- Pilot program & experimental
- University facilities
- Internet scraping



LAB PARTNERS



TOOLS

- Machine learning
- Statistical modeling
- Data mining
- Visualization



APPLICATIONS

- Baseline assessment
- Forecasting & prediction
- Fault detection & troubleshooting
- System optimization
- Market segmentation
- Policy & program evaluation
- Environment assessment



Duke ENERGY INITIATIVE



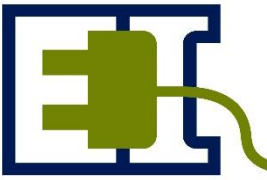
iID SOCIAL SCIENCE RESEARCH INSTITUTE

ENERGY DATA ANALYTICS LAB

SYSTEM PERFORMANCE



Getting Involved



Data+
(Summer 2018)

Bass Connections
(2018-2019 academic year)

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Energy Infrastructure Map of the World

Duke UNIVERSITY | **BASS CONNECTIONS**

[About](#) [Themes](#) [Educational Pathways](#) [Project Teams](#) [Get Involved](#)

[Project Teams](#) » [Energy Data Analytics Lab: Energy Infrastructure Map of the World through Satellite Data \(2018-2019\)](#)



Project Summary

A team of students led by researchers in the [Energy Data Analytics Lab](#) and the Sustainable Energy Transitions Initiative will develop machine learning techniques for automatically mapping global electricity infrastructure using satellite imagery. By identifying substations, transmission lines, and distribution lines, students will create and publish a training dataset that we will use to automate grid infrastructure geolocation. These data and techniques will empower researchers and policymakers to better understand who has grid-connected access to electricity, who is underserved, and how to most efficiently transition communities and countries towards sustainable electrification.

Themes And Categories

[Energy & Environment](#)
[Data+](#), [Energy Data Analytics](#)

Contact

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[APPLY NOW!](#)

Energy Data Analytics Lab: Energy Infrastructure Map of the World through Satellite Data (2018-2019)

Background


Over 15% of humanity has no access to electricity, and far more have unreliable access that precludes most productive energy uses that are beneficial for improving economic prosperity, health and education.

Decision-makers require information to determine the optimal strategies for deploying energy resources to decide where to prioritize development and whether that development should be through grid expansion, microgrids or distributed generation.

However, two critical data sources for such planning—who has access to electricity and the location of electric infrastructure—are often unavailable or overly time-consuming to collect and maintain.

Project Description

To address these needs, this Bass Connections project sets a bold goal of working toward creating an energy infrastructure map of the world using satellite imagery. The project team



Themes

[Energy & Environment](#)

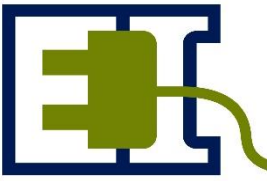
Faculty/Staff Team Members

Kyle Bradbury, Energy Initiative*
Leslie Collins, Pratt School of Engineering-Electrical & Computer Engineering*
T. Robert Fetter, Nicholas Institute for Environmental Policy Solutions
Marc Jeuland, Sanford School of Public Policy
Jordan Malof, Pratt School of Engineering-Electrical & Computer Engineering
Robyn Meeks, Sanford School of Public Policy
Guillermo Sapiro, Pratt School of Engineering-Electrical & Computer Engineering
* denotes team leader

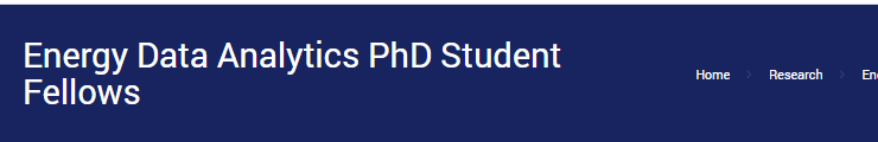
Status

Active, New

Energy Data Analytics Ph.D. Fellowship



SUPPORT US SIGN UP FOR EMAILS CONTACT US



Meet Duke University's 2018-2019 cohort of Energy Data Analytics PhD Student Fellows:

+ BOHAO HUANG (PHD STUDENT IN ELECTRICAL AND COMPUTER ENGINEERING)

+ QINGRAN LI (PHD STUDENT IN ENVIRONMENTAL POLICY)

+ EDGAR VIRGUEZ (PHD STUDENT IN ENVIRONMENT)

+ TIANYU WANG (PHD STUDENT IN COMPUTER SCIENCE)

About the Energy Data Analytics PhD Student Fellows program

The growth of energy-related data in the last decade has created new opportunities for data-driven exploration of solutions to energy problems. Capitalizing on the opportunities presented by this new wealth of data will require scholars with training in both data science and energy application domains. Yet traditional graduate education is limited in its ability to provide such dual expertise. **That's why the Duke University Energy Initiative has established the Energy Data Analytics PhD Student Fellows program, preparing cohorts of next-generation scholars to deftly wield data in pursuit of accessible, affordable, reliable, and clean energy systems.**

<https://energy.duke.edu/energy-data-analytics-phd-student-fellows>

Benefits

- Funding
- Conference travel support and data acquisition support up to \$2,000
- Priority access to virtual machines, storage, and other computational resources
- Participation in a symposium in Spring 2020

If you're a full time doctoral student, consider applying this year!

Funding provided by



**Alfred P. Sloan
FOUNDATION**

Conclusions reached or positions taken by researchers or other grantees represent the views of the grantees themselves and not those of the Alfred P. Sloan Foundation or its trustees, officers, or staff.

ENERGY

data analytics lab



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For questions, contact Kyle Bradbury (kyle.bradbury@duke.edu)