PECAN STREET

Annual Report
FY 2019-2020

pecanstreet.org

From the Board Chair and CEO

Through the tumult of 2020, many non-profit organizations were forced to hunker down, their missions temporarily revised to "survive the year."

We're pleased to report that Pecan Street did much more than survive.

We continued our expansion into new markets. We added new employees, some of whom have never set foot in our office. Our staff flipped COVID restrictions into an opportunity to promote our research through webinars and analyze the impact of stay-at-home orders on home energy use. Building on our work on electricity, water and natural gas, we expanded into soil carbon sequestration research to help find leapfrog technology advances that tap this significant potential climate solution.

And when George Floyd's murder ignited a national reckoning on systemic racism, we committed to bring that reckoning to our organization and the energy industry.

For over a decade, Pecan Street has focused on harnessing the power of data and innovation to accelerate the development of climate solutions. The last year made clear that so many of our challenges are not only connected, but are critically urgent: economic recovery and growth, climate change, racial equity, to name just a few. So, Pecan Street has adopted a Wicked Solutions approach to all our work. We don't have time to solve all of our problems independently, and science tells us we don't have to. We'll look for connections in everything we do and focus our effort toward developing wicked solutions.

As this FY 2019-2020 Annual Report details, Pecan Street ended the fiscal year stronger than it was before, with a renewed commitment to our work and new insight into how our organization can make a lasting impact.

Thank you to our staff and board, our funders, and the scientists around the world who put our research to use and help us pursue our mission.

If you would like to learn more about our research or join our search for climate solutions, please reach out to info@pecanstreet.org.

Sincerely,

Jim Marston
Board Chair

Suzanne Russo
CEO, Pecan Street Inc.

Leadership

STAFF

Pecan Street has built a balanced team of data scientists, entrepreneurs, researchers, coders, city planners, lawyers, engineers, and consumer product experts. We also rely on experienced contractors and consultants to expand our capabilities in new research areas and markets.

Suzanne Russo
CEO

Fisayo Fadelu
CFO & General Counsel

Scott Hinson
CTO

Rachel Jenkins
Director of Operations

Steve Mock
Director of Data &
Information Services

Colin Rowan
Director of Communication

2019-2020 BOARD OF DIRECTORS

Pecan Street is governed by a board of directors that reflects the expertise and diversity of disciplines of our staff, partners and supporters.

- Jim Marston (chair), Environmental Defense Fund
- Dr. Michael Webber (vice-chair), The University of Texas at Austin
- Debbie Kimberly (secretary), Austin Energy
- Cora "Corky" Hilliard (treasurer), Hilliard Resources
- Callie Taylor, Greater Austin Chamber of Commerce
- Dr. Todd Cowen, Cornell University
- Dr. Emma M. Stewart, Lawrence Livermore National Laboratory
- Mitch Jacobson, Austin Technology Incubator
- Jimmy Flannigan, Austin City Council
- Myron Stout, Goldman, Sachs & Co. LLC

Partnerships

Pecan Street's model of change relies on partnerships with the entities that shape our society, including established and start-up companies, universities, public institutions, and citizens.

FUNDERS & PARTNERS

Many thanks to the funders and strategic partners that make our work possible:

Alfred P. Sloan Foundation

Austin Energy

Austin Technology Incubator

Austin Water Utility

Austin Energy

City of Austin

Capital Metro

Cornell University

Cynthia and George Mitchell Foundation

Energy Foundation

Environmental Defense Fund

Landis+Gyr

Lawrence Berkeley National Laboratory

Lawrence Livermore National Laboratory

LG Electronics

National Renewable Energy Laboratory

National Science Foundation

Patrick J. McGovern Foundation

Shell New Energies

Stanford University

The State of Texas

Texas A&M University

Texas Energy Poverty Research Institute

The University of Michigan

The University of Texas at Austin

U.S. Department of Energy

RESEARCH PARTICIPANTS

Our research participants are the heart of Pecan Street's work. Quite simply, we wouldn't be able to do any of our work without them. These volunteer citizen scientists contribute their anonymized energy data to be part of positive and lasting policy and technology improvements. Pecan Street is honored they choose to work with us and trust us with their data.

COLLABORATIONS

In the last fiscal year, Pecan Street joined collaborative groups working in soils, artificial intelligence and public health.

Soils Consortium Members
- Texas A&M University
- Cornell University
- Colorado State University
- Texas Advanced Computing Center (TACC)
- 4p1000 Initiative

Artificial Intelligence Working Group Members
- Agrimetrics
- Cornell University
- GSI Environmental
- Hypergiant Industries
- Indigo Ag
- International Soil Carbon Network
- Lawrence Livermore National Lab
- Rice University's Baker Institute
- Texas A&M University
- Texas Advanced Computing Center (TACC)
- The University of Florida
- Verra Carbon Standard

Texas Global Health Security Innovation Consortium (TEXGHS)
TEXGHS is a collection of academic, public sector, and private sector partners working toward pandemic preparedness and response in Texas. Pecan Street joined the effort shortly after its founding and will contribute data analysis and remote sensing research expertise.

Mission and Program Areas

Climate change is the world's single greatest challenge. Addressing it will grow the economy, improve people's lives, and protect our natural resources and climate.

Pecan Street's mission is to accelerate innovation in climate and conservation solutions and get those solutions to scale faster.

Our work falls into four research areas and leverages three unique disciplines.

Research Areas	Disciplines

Research Areas

ELECTRICITY

Electricity is core to a strong economy and modern life. Reducing its emissions is key to solving climate change. Pecan Street was born from a commitment to redefine our energy system, and finding ways to increase the use of renewable energy and use electricity smarter remains at the heart of our mission.

TRANSPORTATION

Electrifying transportation with emission-free renewable energy is a transformational opportunity to strengthen the grid and reduce climate and local air pollution. Our electric vehicle research created the densest population of consumer EVs in the country and the most robust EV dataset on the planet.

WATER

Water and electricity are closely interconnected. We developed custom sensors and software that turn legacy water meters into internet-connected smart meters that collect high-resolution water data and can determine different in-home end uses.

SOIL

Our work developing custom smart water meter technology led us to soil research. Carbon sequestration under the world's cropland is a remarkable climate solution. We are working with the best minds around the world to advance soil science and measurement technology.

Disciplines

REAL-WORLD, EMPIRICAL DATA

With more than 1,000 members, our volunteer network of residential electricity customers is the largest and most unique "real-world" energy field study on the planet. Collecting electricity use data from multiple circuits in each home every second of every day, Pecan Street's sophisticated sensor network produces 2.5 billion data points a day.

INTEGRATED BIG DATA ANALYSIS

Our energy data is received, anonymized and verified automatically and made available to our partners and clients through Dataport, our custom-designed data interface tool. With more than 2,000 university-sponsored users in more than 60 countries, our data has been cited in 300 peer-reviewed research papers.

TECHNOLOGY INVENTION AND TESTING

Most of our electricity research technology – and all of our water research technology – required custom-engineered hardware and software developed at our lab in Austin. In addition to our own research, our lab offers specialized capabilities for developing, testing and validating consumer electronics, building controls, solar PV, natural gas fuel cell, machine-to-machine, vehicle charging and disaggregation technologies.

2020 — Moving Forward During A Most Unusual Year

It would be the understatement of the century to say that 2020 was a unique year.

Pecan Street had a front row seat to one of the country's first "marquee cancellations" when Austin Mayor Steve Adler called off the SXSW conference on March 6. Our staff had been planning for SXSW, and we realized quite suddenly that all of us would be impacted by COVID. In response to this unprecedented situation, our staff shifted gears and attacked 2020 with renewed enthusiasm.

We received widespread media coverage and provided on-air expertise to the Weather Channel for our unique analyses of how the pandemic and local shelter-in-place orders impacted residential energy use.

Because all our conferences and other events were canceled, we launched a webinar series featuring internal staff and guest speakers from other organizations on a wide range of topics, from our COVID analysis, to regenerative agriculture, to building on Texas' legacy as a clean energy pioneer. The webinars have been so popular, this is one artifact of the pandemic we will continue.

But COVID wasn't the only thing that changed us this year.

The police killing of George Floyd and the necessary public demand for racial justice that followed sparked a remarkable discussion about racism in America and its impacts throughout society. Our collaborator John Hall, the Texas Director for Environmental Defense Fund, consulted closely with our team on Pecan Street's role in undoing racism.

"Energy and race are not often addressed together. But they can and should be... Black and other communities of color are more likely to face energy poverty, to live near fossil fuel power plants, and to suffer the adverse health effects of local air pollution. They're also the most likely to suffer the consequences of a changing climate – from higher temperatures, more frequent drought, and more frequent and stronger storms." – John Hall

Pecan Street's work with partners like John at EDF, Dr. Diana Hernández at Columbia University, and Dana Harmon at the Texas Energy Poverty Research Institute, has sharpened our focus on how a data-driven research organization like Pecan Street can and should engage on this important issue. To help accelerate the process of undoing racism within the energy sector, Pecan Street convened experts on the topic for a webinar series, which can be viewed on our website. We are doing more work behind the scenes to ensure this focus persists – both at Pecan Street and in the climate sector.

And there was an election, too. Though it is too early to know how a Biden administration will impact our work, we are hopeful that a renewed commitment to climate action, scientific rigor and job growth within the clean energy and cleantech industries will provide exciting opportunities for our work and our partners in the coming years.
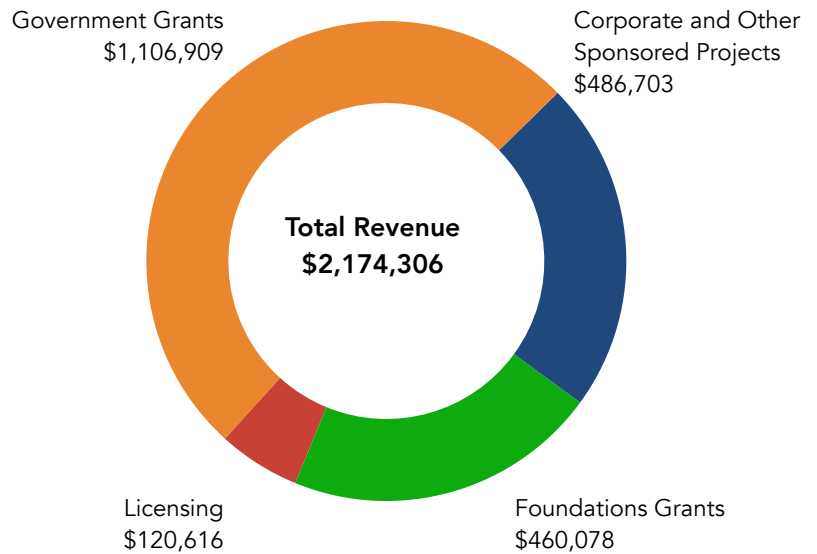
Finances

Amidst a tumultuous year, Pecan Street was able to further diversify our revenue sources and increase our net assets. Total revenue for FY 2019-2020 was $2,174,306. Net assets were $2,634,796.
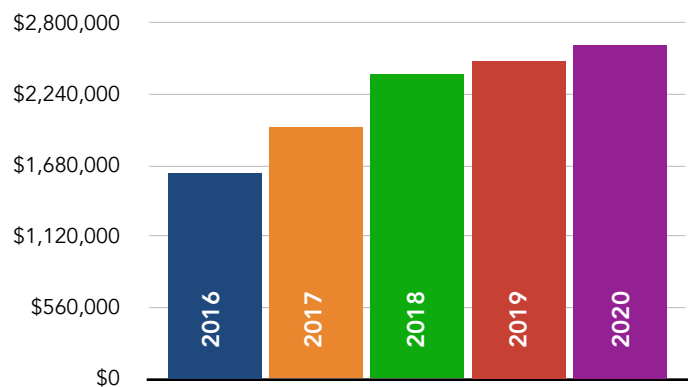
Pecan Street secured a one-year $350,000 award from the Patrick J. McGovern Foundation to fund the groundwork for our Digital Dirt Consortium, under our newly established soils program area.

We expanded our Department of Energy-funded projects with three new one-year subaward contracts executed with the MIT Lincoln Laboratory ($145,000), Eaton Corporation ($103,000) and the Electric Power Research Institute ($102,000).

FY 2019 - 2020 Revenue

Government Grants
$1,106,909

Corporate and Other
Sponsored Projects
$486,703

**Total Revenue
$2,174,306**

Licensing
$120,616

Foundations Grants
$460,078

Net Assets 2016-2020

$2,800,000	
$2,240,000	
$1,680,000	
$1,120,000	
$560,000	
$0	2016 2017 2018 2019 2020

Program Activity

Despite the challenges of our past fiscal year, it was productive and successful. Pecan Street expanded its work in various areas, including demand response, EV and V2G technology, grid resiliency and solar optimization.

Demand Response Research for Eaton
Pecan Street and Eaton Corporation partnered to develop and test a next-generation residential demand response solution that will increase overall efficiency of the electric grid and optimize the use of renewable energy generation resources. Pecan Street assisted with the development of the software platform and in-home hardware to run Eaton's proprietary algorithms and conducted field testing of the system in 75 homes from Pecan Street's energy research network in Austin.

Grid Services and Solar Penetration Research for Eaton
Eaton and Pecan Street joined other partners to develop a next-generation grid services solution and conduct a field trial in an area of high rooftop solar penetration. Throughout the multi-year project, Pecan Street will use our high-resolution energy data from hundreds of homes in our residential research network to inform the DER reserve forecasts and will work with the local power utility to recruit additional homes for a load control field trial and demonstration of the solution in 2023.

> **KEEPING UP WITH PECAN STREET**
>
> You can find more information about our work on our website, linked below.
>
> - Events — Webinars and other virtual and in-person events
> - News — Blogs, press releases and select media stories about Pecan Street
> - Published Papers — Published academic papers that relied upon Pecan Street data
> - Pecan Street Reports — White papers and other material published by Pecan Street

Intelligent Control Research for MIT Lincoln Laboratory
Under this ARPA-E-funded project, Pecan Street joined the MIT Lincoln Laboratory to demonstrate its algorithms for controlling intelligent electrical components in a residential community in Austin. Pecan Street assisted with the development of the software platform and in-home hardware. Plans to field test the system in 25 homes was derailed due to COVID, so Pecan Street tested the system in our lab.

Advanced HVAC Management for University of Michigan
Led by the University of Michigan and supported by UC Berkeley, Los Alamos National Lab, and Pecan Street, this effort will test load control strategies that achieve the performance requirements of typical balancing services at a sufficiently low cost. Pecan Street will use its high-resolution energy data from hundreds of homes in its residential research network to inform the controllers, develop the software platform and in-home hardware, and field test the system in 100 homes in 2022.

Program Activity, continued

Electric Vehicle Supply Equipment Development

Pecan Street successfully developed an open-standard V1G charger in 2020. The Electric Vehicle Supply Equipment (EVSE) interrupter will safely convert any Level 1 or Level 2 J1772 charger into a smart charger that allows for controlled charging, or V1G. Pecan Street will be adding EV control capabilities to help partners develop distributed energy resources (DER) management platforms and provide ancillary services to utilities to create a resilient grid.

PLATFORM for Product Launch

The Department of Energy-backed PLATFORM for Product Launch program leverages Pecan Street's groundbreaking research on residential and small business electricity and water use, integrated data-driven market intelligence, product development and validation, rapid prototyping, and collaboration with venture funding and energy industry executives. Pecan Street tested 15 companies' products at our lab and worked with staff engineers on performance optimization and an investor-quality performance verification report. Together, these companies raised over $1.25 million. The PLATFORM team also produced research on investment tools to support cleantech and building regional cleantech hubs. (Follow links to download reports.)

Grid Resiliency Research for EPRI

In partnership with EPRI, Austin Energy, and national laboratories, the multi-year SOLACE program aims to improve the U.S. power grid's resiliency by using solar and other distributed energy resources to provide power to critical infrastructure (hospitals, water treatment, communication hubs) during times of crisis such as cyber or physical attacks. Pecan Street will deliver insights from high resolution data on residential load and solar generation, engage residential customers to participate in the demonstration in 2022, and identify additional technology needed to make the SOLACE solution viable.

Smart Inverter Functionality Characterization for Lawrence Livermore National Laboratory (LLNL)

The goal of our work with LLNL is to develop data to be used for modeling the dynamic characteristics of smart inverters. In 2020, Pecan Street tested various inverters in a lab setting, and a subset was deployed in residential homes for real-world, longer-term data collection.

Electric Last Mile with Capital Metro

In 2018, the Electric Last Mile (ELM) project piloted electric shuttle services for Austin's Capital Metro in three neighborhoods in Austin to develop models for clean, affordable and efficient last mile solutions. The success of the demonstration led Capital Metro to transition its program to an on-demand neighborhood circulator. In late 2019 Capital Metro began its PickUp by Capital Metro service based on lessons learned from the electric shuttle service. In the next fiscal year, Pecan Street will develop an Autonomous Vehicle Technology guide that draws from our team's lessons learned and experiences with AV technology procurement.

Project Spotlight: Soil Carbon & Artificial Intelligence

Pecan Street is bringing its data and sensor experience to soil and carbon science.

Soil carbon sequestration could be a game-changing climate solution, and Pecan Street thinks harnessing the power of Artificial Intelligence (AI) is the lynchpin to developing proxy measurements that will make agricultural carbon markets economical and scalable.

In 2020, Pecan Street partnered with the Texas Advanced Computing Center (TACC) to convene an AI for Soil Carbon working group to explore whether AI can unlock verifiable, accurate proxy measurements for soil organic carbon (SOC) content over time and what data streams would be needed to do so.

The working group will experiment with proposed machine learning (ML) or AI approaches using TACC's supercomputing capabilities. High-fidelity data from ARPA-E funded SMARTFARM projects will be combined with other identified data sources on TACC's Frontera ecosystem and serve as training and testing datasets for proof-of-concept evaluation. The group began execution of a consensus workplan in 2020 and will release a report of findings in 2021.

AI WORKING GROUP MEMBERS

- Dr. Eric Slessarev, Lawrence Livermore National Lab, Research Fellow, ISCN's Soil Health Coordinator
- Dr. Kathe Todd Brown, University of Florida, Assistant Professor, Environmental Engineering Sciences
- Dr. Dan Harburg, IndigoAG, Vice President of Innovation
- Kenneth Walker, GSI Environmental Inc.
- Dr. Paul Navratil, TACC Director of Visualization
- Stefan Jirka, Verra Carbon Standards
- Dr. Kenneth Medlock, Rice University
- Dr. Nithya Rajan, Texas A&M, Director, Rajan Lab
- Dr. Johannes Lehmann, Cornell University
- Dr. Pramod Pokhrel, Texas A&M
- Dr. Matthew Smith, Agrimetrics
- Dr. Weijia Xu, TACC
- Dr. Zhao Zhang, TACC
- Dr. Marc Boudria, Hypergiant Industries

Project Spotlight: Advancing Electric Transportation

Pecan Street is advancing EV-to-grid integration so cars can become more than just clean transportation.

EVs have been at the heart of Pecan Street's research since 2008. Our founding effort included sparking the highest known concentration of residential electric vehicles on the planet, measuring their impact on energy use and the grid, and analyzing charging needs and behavior.

Since then, our interest and research in EVs has grown. In fact, we see electric transportation as a multiplier technology that can do much more than provide cleaner transportation. If their compatibilities were fully exploited, these rolling power plants could provide stored energy to the grid and align loads with peak clean energy generation.

In 2020, Pecan Street pushed its EV research scope into new areas.

- Completed the Austin SHINES program with Austin Energy, demonstrating the unique and differential value propositions of flexible PV, in-home energy storage and V2G systems.

- Expanded EV charging data gathering from our New York and California participants.

- Developed an open-standard V1G charger that safely converts any Level 1 or Level 2 J1772 charger into a smart charger that allows for controlled charging.

- Developed and deployed a low latency EV charging controller system for a national lab based on the V1G smart charger.

- Launched the V2G University Challenge to develop a robust Vehicle-to-Grid (V2G) control algorithm that optimizes residential fleets of electric vehicles for grid decarbonization and increased resiliency.

- Graduated NeoCharge from our PLATFORM for Product Launch program. NeoCharge produces a Smart Splitter that allows for plug-and-play EV charging access by sharing an existing 220 volt outlet.

- Started analysis into charging trends and resulting home loads for increased range, penetration and charging rate of EVs.

- Analyzed EV charging patterns in the wake of COVID stay-at-home orders and the "new normal" of curbside pickup and remote work.

2021: New Opportunities to Build Back Better

Pecan Street's FY 2020-2021 agenda expands further into equity, soil and other critical climate issues.

We are as eager to start our next fiscal year as we were to finish the last one. Though the pandemic still affects our daily operations and short term planning, we're very optimistic that the remainder of 2021 will present Pecan Street with new opportunities to leverage our unique assets and expertise.

If you would like to learn more about our research or join our search for climate solutions, please reach out to info@pecanstreet.org.

COVID Recovery
Of course, we're looking forward to returning to the office. But more broadly, the Biden Administration's COVID relief and infrastructure plans include the country's largest-ever investment in renewable energy, electric vehicles, grid resilience and other energy and climate issues that fit squarely in Pecan Street's wheelhouse.

We're committed to finding research efforts within the administration's plan where we can support and expand national research teams' capabilities. Moreover, we plan to work with the administration to implement evidence-based policies and programs that ensure a just transition to a low carbon economy.

Texas Energy Crisis Response
In February 2021, Texas leaders learned the hard way that our grid independence has weaknesses that must be (and have not been) carefully managed.

Throughout 2021, we will continue to brief policy makers and regulators about policy and technical changes that would not only reduce the risk of weather-related energy crisis, but ease the impact they have on poor and minority Texans who continue to bear the brunt of weather-related disasters.

Digging Deep on Soil
Pecan Street has just begun our soil and carbon work, but it is, pun intended, fertile ground. Not only does it offer remarkable carbon sequestration potential, the industry can benefit greatly from the remote-sensor and data collection expertise we have refined over the last decade. Further, sustainable agriculture provides a unique opportunity to engage minority-owned farms early and ensure they can participate and benefit from this new field.

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