Innovative Energy Technologies: 
*The Next Generation*

2020 Technology Guide for CMU Startups
THE SCOTT INSTITUTE

The Scott Institute for Research in Energy and Environment at Carnegie Mellon University is at the forefront of energy research. Our work focuses on developing innovative solutions to address the challenges of energy production, consumption, and sustainability. We bring together experts from diverse fields to collaborate on projects that can lead to real-world impacts.

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Next generation energy technologies developed at Carnegie Mellon University have the ability to enhance energy generation and the consumption of that energy in our buildings, transportation, industry and homes. Some of these technologies are just emerging from the minds of Carnegie Mellon University undergraduates, graduate students, researchers, faculty and alumni while others have already entered, or are on the cusp of entering, the marketplace. However, to reap the benefits of these technologies in our everyday lives, it is critical that industry, policymakers and the public support their development from ideas generated in the laboratory to the commercial marketplace.

"CMU is uniquely positioned to support entrepreneurs and innovators. We never know where the next breakthrough in energy will come from, but the Scott Institute helps us find it." - Reed McManigle, CMU Center for Technology Transfer and Enterprise Creation, Mentor-in-Residence and Senior Manager of Licensing and Business Development
**Ecotone Renewables**
Creating Energy through Food Waste

Ecotone’s “Seahorse” system takes in food waste from local grocers, college dorms, restaurants, and more. Through anaerobic digestion principles, Ecotone Renewables reuses food waste to create electricity, fertilizer and fresh produce. Key researchers are Sasha Cohen Loannides and Alexis Hoane.

More information at: ecotonenrenewables.com

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**Aequion Energy**
Storing Electricity in Water-Powered Batteries

Aequion Energy has developed the aqueous hybrid ion battery, a low-cost, long-lasting, large-scale aqueous electrolyte sodium ion battery that uses salt water to store electricity. The company was acquired June 2017. Key researcher is Jay Whitacre.

More information at: aquionenergy.com

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**Edible Electronics**
Organic Sensors that Prevent Health Complications

Edible electronics are biosafe, ingestible sensors powered by stomach acid that could provide information on early signs of bacterial infection, look for symptoms of gastrointestinal disorders, and even study the microbiome living inside people. Key researchers are Christopher Bettinger and Jay Whitacre.


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**Electrochemical Synthesis of Cement**
Rethinking Cement Generation

The production of cement is the largest industrial source of greenhouse emissions in the world. CMU researchers are developing an electrochemical method that would enable the synthesis of cementitious calcium silicate compounds at temperatures at or close to room temperature. This way, one could harness a source of renewable, carbon neutral electricity to produce the exact same product that any cement kiln is producing, but without the greenhouse gas pollution. Key researcher is Venkat Viswanathan.

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**FarmtoFlame Energy**
Providing a Universal Solution for Converting Biomass into Electricity

Farm to Flame Energy converts agricultural waste to electricity in a unique smokeless process at half the cost of diesel fuel. Their revolutionary combustion process burns various forms of biowaste (reduced to fine powder) in place of fossil fuels. This fuel burns as intensely as traditional fuel sources, while being safe for the environment. Key researcher is Kwaku Jyamfi.

More information at: farmtoflameenergy.com

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**GeckoRobotics**
Power Plant Inspections Using Robotics

GeckoRobotics has developed robotic systems to facilitate the inspection of boiler tubes in power plants. Their system is faster, more accurate and safer than current techniques. The company was assisted in its launch by Y Combinator. Key researcher is Troy Demmer.

More information at: geckorobotics.com

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**High-Capacity Lightweight Batteries**
Increasing Battery Capacity through 3D Printing

CMU researchers are using 3D printing methods to create controlled, hierarchically three dimensional porous electrodes for lithium-ion batteries that will increase the battery capacity by at least 50 percent. Key researcher is Rahul Panat.


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**Microfluidic Microbial Fuel Cells**
Creating Power from Organic Compounds

The Microfluidic Microbial Fuel Cell, which includes the world’s smallest low-cost fuel cell, uses microbial electricity generation enabled by microfluidic flow control to produce power from natural organic compounds like bacteria. Key researchers are Kelvin Gregory and Philip LeDuc.

**Mine Vision Systems**  
*Mapping Mines with Accuracy*  
Mine Vision Systems has created a visual system that can be used for the mapping of underground mines with a high degree of accuracy. This accuracy enables monitoring from different perspectives for production, safety and equipment operators.  
**Key researcher** is Brett Browning.  
More information at: [minevisionsystems.com](http://minevisionsystems.com)

**SolePower**  
*Increasing Industry Efficiency through Smart Work Boots*  
SolePower has created self-powering smart work boots that can be embedded with electronics including GPS, motion sensors, Wi-Fi, RFID and lighting. All are charged by the power of walking and can help provide data, signal unsafe conditions, and simplify monitoring of industry and company standards.  
**Key researchers** are Hahna Alexander and Matthew Stanton.  
More information at: [solepowertech.com](http://solepowertech.com)

**Platypus Technologies, LLC**  
*Environmental Monitoring Through Autonomous Robot Boats*  
Platypus Technologies, LLC manufactures small, low-cost autonomous robotic boats that can quickly and efficiently sense environmental contaminants, along with other critical data, such as water depth, dissolved oxygen and pH.  
**Key researcher** is Paul Scerri.  
More information at: [senseplatypus.com](http://senseplatypus.com)

**Sensevere**  
*Sensing Danger in Severe Environments*  
Sensevere provides semiconductor-based sensors for severe environments that detect hydrogen, hydrocarbons, ammonia and bromide. These have the power to improve environmental compliance and safety for the power generation, environmental and chemical industries. Sensevere was acquired in July 2018 by Sensit Technologies.  
**Key researcher** is Jason Gu.  

**Solar Selective Absorbers**  
*Impacting Solar Thermal System’s Design and Performance*  
Solar Selective Absorbers utilize solar thermal energy conversion and a mold stripping method that drastically increase throughput and decrease fabrication cost. These absorbers can significantly impact transformative advancements in solar thermal system's design and performance.  
**Key researcher** is Sheng Shen.  

**Tartan Battery Network**  
*Developing a System for Recycling and Reusing EV Batteries*  
CMU researchers are developing a platform of services to support the reuse and recycling of electric vehicle (EV) lithium-ion batteries. They will assess and adaptively reuse batteries that have reached the end of their life for their initial application.  
**Key researchers** are Jay Whitacre and Wei Wu.  

**Teratonix**  
*Replacing Batteries with Radio Waves*  
Teratonix develops a maintenance-free power source to replace batteries by converting ambient radio waves into electricity to combat challenges of expensive installation and high lifetime maintenance costs.  
**Key researcher** is Yi Luo.  
More information at: [teratonix.com](http://teratonix.com)

**Watt-Learn**  
*Creating a Reliable and Profitable Grid, One Battery at a Time*  
Watt-Learn is developing a cloud-based artificial intelligence software designed to maximize the longevity and value generation of grid-connected energy storage systems. The company’s software maximizes the return on investment of battery projects at different scale, technology and use case while minimizing their degradation — enabling companies to reduce operating costs.  
**Key researcher** is Matineh Eybpoosh.  
More information at: [wattlearn.com](http://wattlearn.com)
Arieca
Developing Soft, Stretchable Metal Alternatives
CMU researchers have developed soft and stretchable materials that have the elastic properties of rubber and the electrical and thermal properties of metal. These materials can be used as stretchable circuit wiring, insulators and heat dissipating substrates. Key researcher is Carmel Majidi.

More information at: arieca.com

Anactisis
Retrieving and Reusing Rare Earth Elements
Anactisis economically recovers rare earth elements, used in many electronic technologies, from coal combustion fly ash to water used for hydraulic fracturing, geothermal energy and mine tailing settlement. Key researcher is Athanasios Karamalidis.

More information at: anactisis.com

ATRP Solutions
Creating Polymeric Materials for Commercial and Industrial Use
ATRP creates well-defined polymeric materials that are utilized in various commercial products and applications like custom materials for oil field chemicals, used for hydraulic fracturing cleanout and drilling. ATRP Solutions was acquired by Pilot Chemicals Co. in July 2017. Key researcher is Krzysztof Matyjaszewski.

More information at: atrpsolutions.com

Blade Diagnostics Corporation
Extending Lifecycles of Integrally-Bladed Rotors
Blade Diagnostics Corporation develops tools and methods for evaluating and controlling how mistuning affects the vibratory response of critical, expensive integrally bladed rotors. Key researcher is Jerry Griffin.

More information at: bladediagnostics.com

Carbon Nanotube Aerogels
High Strength, Light-Weight Materials Without the Cost
CMU researchers are developing methods to link carbon nanotubes (CNT) in aerogel constructs to provide materials that are lightweight and high strength. Aerogel constructs enhance material qualities with very low concentrations of CNTs. Key researcher is Mohammad Islam.


Carnegie Robotics
Improving Productivity, Reliability, and Safety with Robotics
Carnegie Robotics is the industry leader in building highly reliable robotics products to improve productivity, reliability and safety. The company's products have applications in the agriculture, mining, defense and oil and gas production markets. Key researcher is John Bares.

More information at: carnegierobotics.com

CorePower Magnetics
Increasing the Power and Efficiency of Magnetic Materials
The magnetic materials developed at CMU and NETL will increase power density, lower losses, increase efficiency and reduce size and cost in power electronics. The materials are essential elements of a variety of power electronics equipment for electric vehicles and other applications, such as transformers, inverters and motors. R&D 100 Award recipient in 2019. Key researchers are Paul Ohodnicki and Michael E. McHenry.

More information at: https://bit.ly/2x7RbhY

Fifth Season
Vertical Farming with Automated Robotics
Fifth Season develops automated robotics and software analytics to make indoor agriculture more efficient and environmentally friendly. The company grows produce using smart, indoor vertical farms that utilize 95 percent less water and increase labor efficiency by over 50 percent. Key researcher is Austin Webb.

More information at: fifthseasonfresh.com
Integrated Silicon Technologies

Cutting Costs on Continuous Casting

CMU researchers are developing an improved continuous casting process for making solar silicon wafers that will have dramatically lower cost by simplifying a formerly complex, expensive and wasteful process. **Key researcher** is Erik Ydstie.


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Grid Fruit

**Bringing Data-Driven Intelligence to Food Retail Operations**

CMU researchers are developing software for dynamic, distributed, parallel management of load balancing in electric power distribution networks. The initial application is dynamic control of commercial refrigeration, to reduce energy costs and provide better control over maintenance costs. **Key researchers** are Souramya Kar, Javad Mohammadi and Jesse Thornburg.

More information at: [gridfruit.com](http://gridfruit.com)

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Liquid X Printed Metals

**Pushing the Boundaries of Functional Electronics Fabrication**

Liquid X Printed Metals are functional metallic inks with wide-ranging applications within the printed electronics and additive manufacturing markets. These inks operate at the atomic level, allowing for processing advantages and better film properties than other metallic links. **Key researcher** is Richard McCullough.

More information at: [liquid-x.com](http://liquid-x.com)

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Plextronics

**Energy-Efficient Electronic Ink Manufacturing**

Plextronics, an international technology company, specializes in electronic inks for OLED displays, and lighting and electronic polymers. Electronic “inks” enable cheaper, more energy-efficient electronics, such as TVs and lighting applications. Plextronics was acquired by Solvay in March 2014. **Key researcher** is Richard McCullough.


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The Optimization Firm

**Using Mathematical Models for Decision Making and Saving Costs**

The Optimization Firm offers high-performance computing solutions for complex numerical optimization problems that help companies make complex decisions based on mathematical models. These slight improvements in operations yields savings of millions of dollars. **Key researcher** is Nick Sahinidis.

More information at: [theoptimizationfirm.com](http://theoptimizationfirm.com)

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Vortxx Semiconductor

**Current Generation Fabrication Equipment with Next-Gen Impact**

This CMU spin-off is designing products that will reduce the density of electronics, therefore lowering power consumption. This approach achieves “next-generation” Moore’s Law levels of performance while being able to utilize current generation fabrication equipment. **Key researcher** is Wojciech Maly.


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Building Ideas Group (BIG)

**Energy Management for your Building Portfolio**

BIG is a CMU spin-off developing data collection systems using energy usage analytics and visualizations to reveal actionable information for building occupants, managers and owners. BIG’s review of energy savings opportunities helps facility managers target projects with the best return on investment. **Key researcher** is Azizan Aziz.


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Building Model Data Extraction Software

**Building Model Simulation Made Easy**

Lam’s software automatically pulls data from digital building design models and populates data into the correct fields of compliance documents, saving days to weeks of time spent with the LEED application process. This software was licensed by Design Builder for state of the art building performance analysis. **Key researcher** is Khee Poh Lam.

More information at: [designbuilder.com](http://designbuilder.com)
Commercial Facility and Residential Energy Management

BuildSimHub Inc.
One Platform for All Energy Modeling Needs
BuildSimHub Inc. provides energy modeling solutions throughout a building's life cycle as well as innovative technologies, like the first GIT-based energy model management system, to make energy modeling more efficient and accessible by the AEC industry. Key researcher is Weili Xu.

More information at: buildsim.io

Conservation Labs
Affordable Smart Water Technology to Manage Water Consumption
Conservation Labs is commercializing an easy-to-install water usage monitoring system, H2know. This system takes measurements from water pipes every second using patent-pending technology and a machine learning approach to translate those signals into accurate water flow estimates, leak alerts, and water insights. Key researcher is Mark Kovscek.

More information at: conservationlabs.com

EEme, LLC
Converting Big Data into Actionable Energy Insight
This CMU spin-off processes data to predict the technical and behavioral energy efficiency (EE) potential and provide personalized EE recommendations for every residential user in a given service territory. Managers can also analyze their customers using the utility heat map dashboard. EEme, LLC was acquired by Tendril, January 2019. Key researcher is Enes Hoşgör.


Encapsulated Phase Change Material Containers
Reducing Heating and Cooling Costs through Phase Change Containers
CMU researchers are designing a range of "containers" that are configured as decorative or functional architectural tiles, window shade louvers, furniture and other devices that are optimized to enable air flow and heat exchange, potentially reducing the cost of heating and cooling by 25 percent. Key researchers are Dale Clifford and S.C. Yao.


Heat Dissipating Architectural Panels
Reducing Energy Cost and Consumption Using Custom Architectural Panels
CMU researchers are developing a CAD platform for creating custom architectural panels that incorporate thermodynamic principals of air flow to dissipate heat and reduce building energy usage. They are also developing 3D printing fabrication methods for these concrete architectural panels to provide a cost-effective system to enable creative, energy-efficient design. Key researchers are Dana Cupkova and Josh Bard.


LeanFM Technologies
Saving Energy in Commercial Building Systems Using AI
LeanFM Technologies is a lifecycle software solution for economic, proactive and intelligent facilities management that leverages building information modeling and cloud computing technology to integrate heterogeneous building information recorded in disparate media. Key researchers are Burcu Akinci and Xuesong Liu.

More information at: leanfmtech.com

MellonHead Labs
Monitoring Residential and Environmental Water Quality
MellonHead Labs is a CMU spin-off developing water sensors that can be used to monitor changes in water quality inside the home or outside in streams, rivers and ponds, with a simple graphic representation of the interpreted data collection. Research facilitated by the CMU CREATE Lab.


Module
Housing Designed to Grow alongside the User
Module's end-to-end platform, construction technology, and pay-as-you-go housing solution creates a sustainable, energy-efficient starter home that provides an affordable, flexible entry point for homeownership. Key researcher is Hallie Dumont.

More information at: modulehousing.com
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<td>SparkMeter</td>
<td>Offering Comprehensive Low-Cost Metering Solutions for Grids</td>
<td>Anthony Rowe and Dan Schnitzer</td>
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<td>A Trucking Revolution that Reduces CO2 Emissions and Fuel Consumption</td>
<td>Thomas Healy</td>
<td><a href="http://hyliion.com">hyliion.com</a></td>
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<td>CMU researchers are developing a non-sensor based method of determining parking spot availability, which incorporates an ability for drivers to reserve a parking spot while enabling the parking operators to implement dynamic pricing schemes to optimize the use of limited spaces. It also enables low-cost, efficient and crowd-sourced enforcement. Key researcher is Sean Qian.</td>
<td><a href="https://bit.ly/2VyKgqq">https://bit.ly/2VyKgqq</a></td>
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Rapid Flow Technologies
Optimizing Traffic Signals Using AI to Help Drivers

Rapid Flow Technologies combines research from artificial intelligence and traffic theory to optimize traffic signals for the traffic that is actually on the road. This leads to less waiting, reduced congestion, shorter trips, less pollution and happier drivers. **Key researchers** are Greg Barlow and Stephen Smith.

More information at: rapidflowtech.com

Regionally-Aware Traffic Incident Response Management System
Understanding and Predicting Travel Time

Traffic management centers attempt to dynamically manage roadway traffic to respond to real-time incidents, such as disasters, crashes, events, flooding, etc. CMU researchers are developing a machine-learning based system that incorporates incident, weather and other real-time data, with a predictive assessment of how incidents in one sector will impact traffic flow throughout a regional traffic system, and provides proactive mitigation solutions in real time. **Key researcher** is Sean Qian.

More information at: https://bit.ly/2yiPBKt

RoadBotics
Enabling Data Driven Decisions through AI and Smartphones

RoadBotics uses computer vision and machine learning to analyze and map road conditions and irregularities. The technology can detect pothole severity, snow conditions on roads, signage visibility and much more. **Key researcher** is Christoph Mertz.

More information at: roadbotics.com

Virtual Traffic Lights
Eliminating Physical Traffic Lights with Autonomous Vehicle Communication

With this technology, cars and trains autonomously communicate with each other to determine right of way at intersections without traffic lights. Computer simulations indicate a potential 60 percent improvement in traffic flow in a full-city simulation. **Key researcher** is Ozan Tonguz.

More information at: virtualtrafficlights.com
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