Request for Proposals: 15 Small Grants for Research to Reduce Climate Change

Manhattan 2 Group, Inc. (Ma2) is a US-based non-profit corporation that develops standardized plug-and-play energy infrastructure that reduces CO_2 emissions. Ma2 (www.Manhattan2.org) intends to award up to 15 small grants ($5K each) in 2020 for developing electrical, mechanical and software technology that reduces climate change. Applicants are to select from one of the ten topics listed below and **submit their proposals by March 15, 2020**. Undergraduate Students, Graduate Students, Professors, and Degreed Professionals; of any nationality; residing at any USA or Int'l location are eligible. For information on how to apply and program details, please download to your desktop Excel file "Ma2_Grant_Application_Form_1Q2020.xls" by clicking here. To discuss your ideas or receive help with your proposal, email gWeinreb (at) Manhattan2 (dot) org with "Ma2 1Q2020 YourOrganization YourName" in subject line. Acceptable topics are as follows:

1. **Develop Standardized Plug-and-Play Solar PV Panels with Embedded Electronics and Embedded Conductors for Land, Commercial Roofs and Direct-to-Building Surfaces**
   Mechanical or Electrical Engineering

   Develop next generation standardized PV panels with embedded electronics and embedded conductors. For example, one might design a standardized 2x10 meter panel that stacks on the back of a flatbed truck and is installed via crane. Mechanical engineers design mechanical systems for large solar panels on land (solar farm), commercial roof (e.g. 30x100 meter roof on metal framing), or direct-to-plywood roof or wall (e.g. for residential). Assume automated machinery is available for installation. System must support replacement and/or repair in the event of fault. Using 3D mechanical modeling software; show design and simulation for ~50 years of UV, wind, rain, hail strike, erosion and thermal cycling. Electrical engineers design circuits for embedded electronics and off-panel modules that further process electricity. Applicants may propose mechanical standards, electrical connector standards and communication standards. Applicants may also propose Building Codes and National Electrical Code for Building Integrated PV. For details, click here.

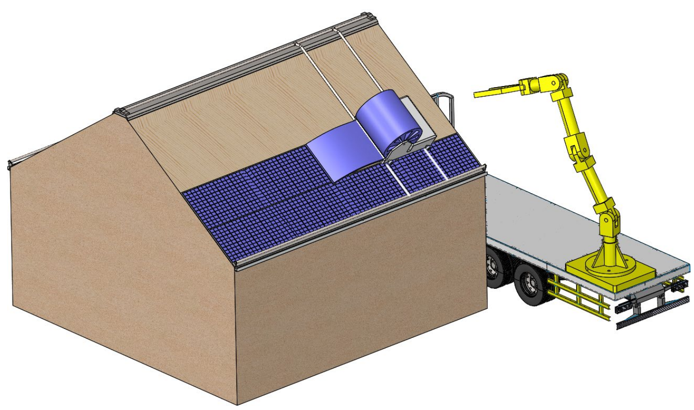
2. **Develop Mechanical System for Large Solar Panels on Land,** *Mechanical Engineering*

Develop a standardized mechanical system that supports PV panels with embedded electronics and embedded conductors that connect together on land within a solar farm. Mechanical engineers explore flat (e.g. 2x10m panels) and/or rolled designs (e.g. spool of 2x50meter 1cm thick material that rests on metal framing). For details, click here.

3. **Develop Mechanical System for Large Solar Panels on Commercial Roof** *Mechanical Engineering*

Design a mechanical system for large PV panels with embedded electronics and embedded conductors that mount on commercial roof. Consider systems where rigid PV panels implement roof structure and water barrier (e.g. 2x10meter corrugated steel panel with built in solar) as well as non-water-barrier systems that are placed on top of a traditional roof. Mechanical engineers can look at flat panel designs or rolled material. For details, click here.

4. **Develop Mechanical System for placing Solar PV Direct-to-Building Surfaces (BiPV)** *Mechanical Engineering*



Design mechanical system for placing solar material with embedded electronics and embedded conductors directly onto building surfaces, including both wall and roof. Assume:

- Material provides water barrier.
- Material is supported by installation machinery (e.g. truck with articulating arm accurately routes grooves & drills holes in plywood and handles large spools of rolled material).
- Material is prepared in factory with features using architectural drawings (e.g. cut holes in material at specific locations to support vents).
- Material supports repair and/or replacement.

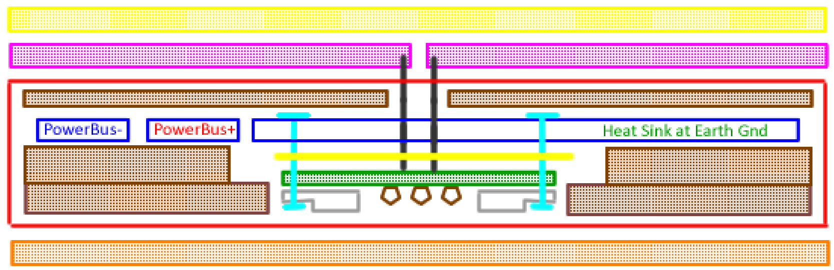
5. Develop Embedded Electronics for Large Standardized Plug-and-Play Solar PV Panels

Electrical Engineering

Develop electronics for large standardized plug-and-play solar panels. Analyze the various electrical options, calculate costs, design circuits, and build prototypes. Assume:

- Large solar panels contain two internal bus conductors (e.g. each 0.5mm x 80cm x 10meters aluminum) for routing current, providing mechanical strength, and supporting a heat sink for electronics.
- An embedded electronic converter circuit manages each ~1 square meter of solar for purposes of MPPT (maximum power point tracking), fire prevention (turn off in event of fault), and degradation management (shading one area does not affect entire array). For example, a researcher might design a 45VDC-to-40VDC DC-to-DC converter (e.g. 300W, $25 parts cost, $0.08/Watt, 8mm tall components) that is implemented with a ~$2 microprocessor and networked via CANbus. Note that low voltage non-isolated DC buck converter circuits are typically lower cost and lower height than higher voltage isolated AC circuits (for an example, see this TI design report). If one combines 8 of these in series to produce a 300VDC substring, and then combines 8 substrings in parallel, they could create 300VDC/64A/19kW inside a 1cm thick panel assembly via low cost buck converters, which later drive an off-panel 300VDC-to-110VAC grid-tie inverter, for example (e.g. 2nd stage of typical string inverter). Combining ~300W circuits is tricky -- researchers need to work out details. Researchers evaluate different voltage/current schemes and look for lowest system cost focusing on three applications: residential (e.g. 5kW to 20kW, 110 or 220VAC system grid tie output), commercial roof (e.g. 100kW to 1MW, 440VAC system grid tie output), and solar farm (e.g. 1MW to 100MW, 1KV to 30KV AC or DC site output).
- System is resistant to faults from internal ~300W converter. For example one might have two MOSFETs that open in the event of fault. One MOSFET might sit between solar PV and converter PCB, and another between converter PCB and common current bus.
- Converter PCB monitors internal nodes via A/D (e.g. input current/voltage input, output current/voltage, capacitance of input capacitor, capacitance of output capacitor, inductance of main inductor, etc.).
- Failure of any Converter PCB component (e.g. to short or to open), or a short circuit between any two nodes, does not create enough heat to cause fire or melt material.
- Converter PCB shuts down system in event of high temperature or current detected on earth ground shield (e.g. due to insulation failure between conductor and enclosure).

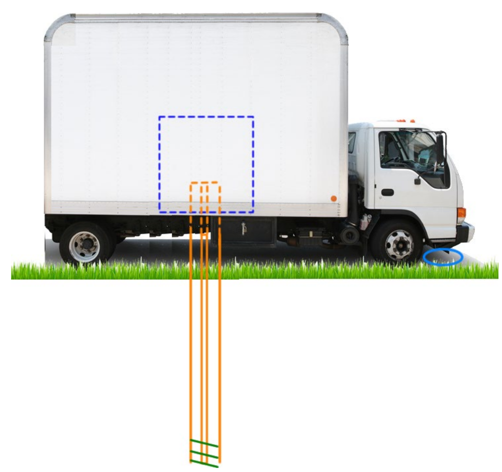
- Panels clip together, end-to-end in a standardized way (e.g. four 2x10m panels form 2x40m assembly).
- Assemblies terminate at a spine on land, or cavity inside building. It is here that electricity on bus conductors (e.g. 300VDC, 64A, 19kW) is converted to something more useful (e.g. 110...220VAC for buildings and 660...1440VAC for solar farm) via a string inverter module designed by researchers.
- The illustration to the right shows an example stack-up for building integrated PV material, looking in from the end and not drawn to scale (e.g. 2 meters across x 12mm high). Glass is yellow, solar PV is purple, PCB is green, power bus plate and heat sink is blue, TO-220 mosfet is gray, insulation is brown and base support material is orange (thermal insulation, mechanical support). Aluminum foil (red) is connected to earth ground to reduce RFI radiation and enable ground fault protection (turn off panel in the event voltage is detected at foil due to insulation failure).



- Electrical engineers explore the various options for moving electricity on land and on building surfaces, with rough designs and cost models. Researchers assume they are working with large panels that contain embedded electronics and embedded conductors. For more details, see Chapter "DC-to-DC Optimizers Embedded into Solar Material" in this file.

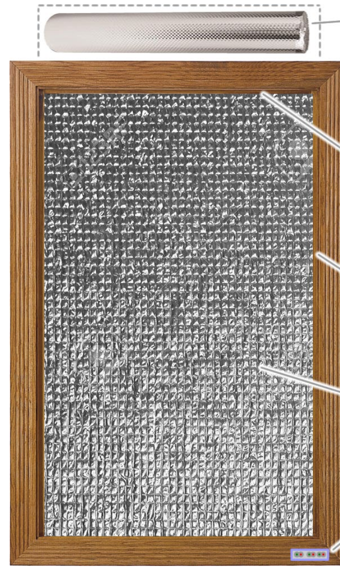
6. Develop methods to Reduce Cost of Drilling Ground Source

Mechanical or Civil Engineering



Design a machine that utilizes an independent drilling mechanism that worms its way into the ground instead of the traditional method of drilling (e.g. rotate heavy pipe that traverses entire length of drill hole with ~10,000 Kg of downward pressure). If one circulates 55°F ground water through a heating/air conditioning heat pump, instead of outside air, they can reduce space heating/cooling energy consumption approximately 2 to 1. The problem is it is expensive to install underground piping through which one circulates water. The aim of this project is to reduce the cost of installing this pipe. For details, click here.

7. **Develop Motorized Window Thermal Cover Devices and Standards**
Electrical Engineering or Computer Science



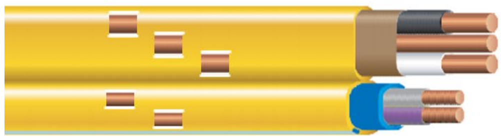
Develop a controller PCB that manages a motorized rolled window thermal blind to cover a window. For example, one could have a ~$2 microprocessor drive a stepper motor, sense torque, and interface to a DALI lightning network (i.e. 110/220VAC power wires and two digital wires). This inexpensive PCB might be seen as a light on the DALI network where 0-to-100% illumination corresponds to 0-to-100% deployment of thermal cover. While motorized thermal cover products already exist they are not readily used because there is no standardized, reliable, and low power method to connect them to a building (wireless does not meet these requirements). It is our goal to change this with mechanical, electrical connector, and wired communication standards proposed by researchers. For details, search "stepper motor", "thermal cover", "DALI Development Kit", "DALI Slave Reference", and "Digital Addressable Lighting" within this file.

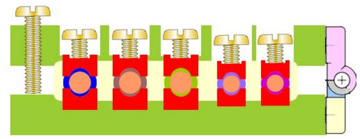
8. **Develop Next Generation 2-Wire Data Signaling System, Similar to RS-485 yet Better**, *Electrical Engineering*

Currently the DALI lightning network standard uses two wires in a tree wiring topology to transfer data between lights and other devices in a building at 1200 bits per second. Researchers develop a new version of DALI which supports up to 80K bits/second, supports tree topology, is electrically isolated, and is protected against damage in the event of accidental connection to 110/220VAC. For details, search "DALI 3 electrical signaling standard" within this file.

9. **Develop Next Generation Mechanical System for Routing Power Wires within a Building, Similar To Romex 3-wire Cable yet Better,** *Mechanical Engineering*

Power wiring connections are typically implemented with screw force, where a screw head presses against a wire with thousands of pounds-per-square-inch of force. This creates reliable connections that last ~100 years. Researchers develop an alternative system for power wiring connections that supports adding two data wires to the typical 3-wire Romex cable, for purposes of automation and control. The proposed system must have reliability equal to or better than existing screw force systems, and installation time does not increase due to a motorized hand tool proposed by researchers. For details, search "Connector Hardware Research" within this file.





10. Develop Next-Generation Building Automation and Control Systems & Standards

Electrical Engineering or Computer Science

There are many technologies researchers can develop to support next generation building automation and control that reduces CO_2 emissions. For research ideas, click here.

Resources

Grant Application Files, Available for Download

- Request for Proposal -- Grant to Develop Low CO_2 Technology, Manhattan 2, 1Q2020
  http://www.ma2.life/doc/research/RFQ_2020_1Q/Ma2_Grant_RFP_1Q2020.pdf

- Grant Application Form, Manhattan 2, 1Q2020, Excel .xls file
  http://www.ma2.life/doc/research/RFQ_2020_1Q/Ma2_Grant_Application_Form_1Q2020.xls

- Grant Application Agreement
  http://www.ma2.life/doc/research/common/Ma2_Grant_Application_Agreement.pdf

- Collaboration Agreement
  http://www.ma2.life/doc/research/common/Ma2_Engineer_Agreement.pdf

- Manhattan 2 Research Collaboration System
  http://www.ma2.life/doc/research/common/Ma2_Collaboration_System.pdf

Manhattan 2 R&D Initiatives

- PowerPoint Presentation: R&D to Create a Low Carbon Society via Manhattan 2
  http://www.ma2.life/doc/plan/Manhattan2_PPT_Summary.pdf

- List of Articles Published by Manhattan 2 in National Media
  http://www.ma2.life/doc/plan/Manhattan2_Published_Articles.pdf

- R&D Plan to Develop Next-Generation Building Automation & Control Systems & Standards
  http://www.ma2.life/doc/plan/Ma2_IOT_Development_Plan.pdf

- R&D Plan to Create Standardized Plug-and-Play Solar Direct to Building Surfaces & Land
  http://www.ma2.life/doc/plan/Ma2_Solar_RD_PLAN.pdf

- R&D Plan to Automate Installation of 55°F Ground Source for Heat Pump
  http://www.ma2.life/doc/plan/Ma2_Vertical_Ground_Source_RD_Plan.pdf