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Problem Diagram

(Analogous to a Statement of Work for a Non-Wicked Problem)

Global Solutions and Outreach Programs (GSOP)

The three-year Global Solutions and Outreach Programs (GSOP) aims to develop national, regional and global action plans that, when implemented, will successfully solve the global warming/climate change problem – a problem that threatens the future wellbeing of our children, grandchildren, future generations, and the survival of Modern Civilization**.**

The GSOP is comprised of two mutually supporting programs: the international Global Solutions Program that focuses on national, regional and global solutions, and the international Outreach Program that provides engineering advice and support to States, local communities and industries taking action on global warming. Together, the two programs will bring States, local communities and industry into the problem-solving efforts along with national, regional and global teams of engineers, economists and other specialists. All participants will work in concert and share results through the Internet. Together, they will develop honest, practical solutions that are physically successful in Earth's terms in stabilizing and adjusting its energy balance and solving other problems, and successful on human terms of economic and social/political acceptability for each Nation and their States, local communities and industries.

Problem diagrams for each of three People's Projects comprising the Global Solutions Program and for the Outreach Program are presented below. A separate three-page Program Summary and White Paper presents the rational, strategy, costs, and results of the GSOP. This paper can be found on our website at www.climate-collaboration.com.

Note: The GSOP Problem Diagrams and associated plans (Personnel Plan, Cost Plan, and Start-Up Plan) can serve to define and initiate the GSOP within the US as well as internationally. As young engineers, economists, social experts, and other specialists are hired and begin to execute programs, they will further improve the Problem Diagrams based on their experiences and steep learning curves. This flexibility is a necessary aspect of the wicked-problem approach in solving highly complex wicked problems. The GSOP Cost Plan is the one exception. Every effort must be made to execute the GSOP within the planned costs, which should be adequate. US Army experience using the wicked-problem approach dmonstrated this ability.

Note: "Internal Reporting" noted throughout the GSOP Problem Diagram is used to frequently exchange GSOP status, information, results and good ideas among all national and international GSOP participants as well as those they interface with. This exchange is needed to build learning and support ongoing collaboration among all participants. The internal reports will be placed onto the GSOP Global Platform and freely accessible. External GSOP progress reports will be prepared by the Administration Team to periodically inform the public, government officials, and GSOP sponsors on GSOP progress. These will be based on the information in the internal GSOP reports.

Global Solutions Program – Problem Diagrams

The Global Solutions Program is comprised of three People's Projects. People's Project 1 focuses on halting the net release of CO_2 and adapting to unavoidable climate change impacts. People's Project 2 will determine how best to stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and solve ocean acidification and other problems. People's Project 3 addresses climate monitoring, models and future conditions, and advanced technologies in support of Projects 1 and 2. The three projects will identify options and actions necessary to achieve their goals by the years 2050, 2075 and 2100. Problem diagrams are presented below for each of the three projects.

People's Project 1.
Halt Net Release of CO_2 & Adapt to Unavoidable Climate Change Impacts

Project 1 Goals

Project Goal: Identify and evaluate available approaches to halt the net release of atmospheric CO_2, and adapt to unavoidable climate change impacts by 2050, 2075 and 2100. Develop integrated national strategies and action plans that are technically feasible and effective, economically supportable and social/political acceptable and supported by *the people*. Assist to develop international regional and global strategies and action plans that are likewise technically feasible and effective, economically supportable and social/political acceptable and will, when implemented, successfully overcome global warming. Interface closely with the Outreach Program to provide a two-way flow of information and collaboration between local and national levels to achieve a broad and powerful focusing of many minds. Encourage other nations to establish similar Global Solutions and Outreach Programs to ultimately arrive at feasible and effective mixes of climate solutions for each Nation and its States, local communities and industries, and to achieve feasible and effective international regional and global solutions.

End-State Goal: Best practical approaches are in place internationally and functioning successfully to halt the net release of CO_2, cope with unavoidable climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification and other problems.

Project 1 Problem Elements (Questions and Barriers)

Organization Problem Elements – National Team

(1) How best to select, orient, organize and facilitate national teams and sub-teams to accomplish People's Projects 1?

Standardization and Information Technology Problem Elements – National Team

(1) Standard parameters need to be selected and agreed upon for use in this project so that results can be accurately compared and integrated both nationally and globally.

(2) A robust global platform is required to facilitate communications and collaboration nationally, regionally and globally in support of GSOP.

Technical Problem Elements – National Teams

Halt the net release of atmospheric CO_2 by 2050, 2075 and 2100 Problem Elements – National Teams

(1) What are the current national, regional, worldwide energy consumptions by type of energy and associated releases of CO_2 from each energy type?

(2) What are the available, proven options to fill energy needs nationally that do not produce greenhouse gases? What are the standardized technical evaluation criteria that each option must be evaluated against? What are the results of evaluating each option against these criteria?

Adapt to unavoidable climate change impacts by 2050, 2075 and 2100 Problem Elements. – National Teams

(1) From what areas and how many people nationally will be forced to evacuate due to expected levels of ocean rise by 2050, 2075 and 2100?

(2) From what areas and how many people nationally will be forced to evacuate due to expected rises in temperatures by 2050, 2075 and 2100?

(3) From what areas and how many people nationally will be otherwise severely impacted by anticipated climate changes via rainfall, storms, temperatures by 2050, 2075 and 2100?

(4) What are practical options to cope with and mitigate these impacts? What are the results of evaluating each option on standardized technical evaluation criteria?

Integration & Internal Reporting Problem Elements – National Teams

(1) What would be an integrated national system to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100? First consider available options from People's Projects 1 and 2, and then combine available options and R&D options from People's Projects 1, 2 and 3.

(2) What is the resulting best practical systems that balance technical, economic and social/political factors.

(3) With this integrated strategy, what would the national total annual release of CO_2 be by years 2050, 2075, and 2100? Based on the integrated strategy, what would the anticipated total national contributions be to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification & other problems by years 2050, 2075 and 2100?

(4) How can this strategy be successfully implemented?

(5) Once a successful global strategy is developed, what are the plans to implement the national strategy?
(6) How can national and international project participants be kept informed of GSOP progress and results?
(7) What information needs to be exchanged between the Outreach Program and the Global Solutions Program and how is this to be accomplished?

Economic Problem Elements – National Teams

(1) How can the cost analyses be determined on a consistent basis nationally, regionally, worldwide?
(2) What is the total capital and yearly national costs of an integrated strategy to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100?
(3) How can these costs can be funded and what is the affordability of paying these costs?
(4) How can economic barriers be overcome?
(5) The Integration Team needs to be kept informed of economic assessment results.

Social/Political Problem Elements – National Teams

(1) How can social/political evaluations be conducted to determine social/political acceptability for each option considered in Project 1, 2 and 3?
(2) What are the social/political acceptability and barriers of an integrated system to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100?
(3) How might these barriers can be overcome to successfully achieve the integrated strategy?
(4) The Integration Team needs to be kept informed of the social/political assessment results.

National & International WPA Training and GSOP Orientation Work Units – National Team

(1) National and international GSOP participants will need to fully understand the WPA and the GSOP. They will need a POC to go to for advice and questions.

Coordination, Integration & Internal Reporting Problem Elements – Regional Teams (National Tams Participating)

(1) What regional information is needed regarding CO_2 release?
(2) What regional information is needed regarding contributions to meeting GSOP goals?
(3) How can this integrated regional strategy can be successfully implemented.
(4) What is the final product from each region?
(5) What progress reports are needed and how will they be shared?
(6) Coordination with the regional teams will be needed.

Economics Problem Elements – Regional Teams (National Teams Participating)

(1) What will be the capital and yearly costs to meet GSOP goals?
(2) How can these costs can be paid for and what is the regional affordability?
(3) What progress reports are needed how will they be shared?

Social/Political Problem Elements – Regional Teams (National Tams Participating)

(1) What are the social/political acceptability and barriers for each region to meet GSOP goals?
(2) How can these barriers can be overcome to successfully achieve integrated regional strategies?
(3) What progress reports are needed how will they be shared?

Coordination, Integration & Internal Reporting Problem Elements – Global Teams (National Tams Participating)

(1) What regional information is needed regarding CO_2 release?
(2) What regional information is needed regarding contributions to meeting GSOP goals?
(3) By implementing the integrated global strategy, what will global conditions be with respect to GSOP goals?
(4) What can be done if these conditions are not acceptable?
(5) Can more intense or additional available approaches be implemented to meet GSOP goals?
(6) Are there key technical barriers to successfully meeting GSOP goals?
(7) What technologies in R&D (People's Project 3) that can overcome these key technical barriers?
(8) How best to determine if additional and more intense available approaches plus R&D technologies from People's Project 3 can achieve GSOP goals?
(9) How can the successful integrated global strategy can be successfully implemented?
(10) What is the final product regarding the resulting global strategy?
(11) What progress reports are needed how will they be shared?
(12) Coordination with the global teams will be necessary.

Economics Problem Elements – Global Teams (National Tams Participating)

(1) What will be the global capital and yearly costs to meet GSOP goals?
(2) How can these costs can be paid for and what is the global affordability?
(3) How can economic barriers be overcome?
(4) What progress reports are needed how will they be shared?

Social/Political Problem Elements – Global Teams (National Tams Participating)

(1) What are the social/political acceptability and barriers globally to meet GSOP goals?
(2) How can these barriers be overcome to successfully achieve the integrated global strategy?
(3) What progress reports are needed how will they be shared?

Project 1 Solution Work Units (Options & Actions)

Organization Work Units – National Team

(1) Project 1 Core Team: Select, orient, organize and facilitate national teams and sub-teams to accomplish People's Projects 1.

Standardization and Information Technology Work Units – National Teams

(1) Standardization Parameters – Standard parameters need to be selected and agreed upon for use in this global project so that results can be accurately compared and integrated nationally, regionally and globally. Standardized parameters include a base year, the different regions of the earth to be addressed, and standardized units of measurement for mass, energy, greenhouse gas concentration,

temperature, and other parameters. Assist to develop international, regional, and global agreement on these parameters and provide standardization support to People's Projects 1, 2, and 3.
(2) Information Technology – Identify, select, and support a communications platform to enable the communication and collaboration of thousands of engineers, economists, social/political experts and others working on the GSOP from around the world; and the storage and distribution of national, regional and global reports and results. Support use of the platform nationally, regionally and globally in People's Projects 1, 2, and 3.

Technical Work Units – National Teams

Halt the net release of atmospheric CO_2 by 2050, 2075 and 2100 Work Units – National Teams
(1) Baseline – Identify the current national energy consumption by type of energy and associated release of CO_2 from each energy type.
(2) Identify available, proven options and sources of information for each category listed below. Consider the attached partial list of options as a starting point and survey nationally and internationally for additional categories and options to meet above objectives. Analyze each option on the attached technical evaluation criteria. Seek out and engage with subject matter experts in government, industry, universities and climate action groups to obtain factual information and data to enable your assessments.

Clean Energy
Energy Storage
Winter Energy Sources
Energy Conservation
Social actions
Industrial Carbon Capture & Sequestering

Adapt to unavoidable climate change impacts by 2050, 2075 and 2100 Work Units. – National Teams
(1) Ocean Rise – Project from what areas and how many people will be forced to evacuate due to expected levels of ocean rise by 2050, 2075 and 2100.
(2) Temperature Rise – Project from what areas and how many people will be forced to evacuate due to expected rises in temperatures by 2050, 2075 and 2100.
(3) Severe Weather – Project from what areas and how many people will be otherwise severely impacted by anticipated climate change via rainfall, storms, temperatures by 2050, 2075 and 2100.
(4) Identify available, proven options to adapt to unavoidable climate change impacts by 2050, 2075 and 2100. Consider the attached partial list of options as a starting point and survey nationally and internationally for additional categories and options to meet above objectives. Analyze each option on the attached technical evaluation criteria. Seek out and engage with climate action groups experts in government, industry, universities and special-interest groups to obtain factual information and data to enable your assessments.

Integration & Internal Reporting Work Units – National Teams
(1) Systems Integration – Develop integrated systems of available options from People's Projects 1 and 2 to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy

balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.

(2) Technical, Economic and Social/Political Evaluations – Combine and balance technical, economic and social/political evaluations into best practical integrated systems by years 2050, 2975 and 2100.

(3) National Contributions – Based on the best practical integrated systems, determine what the national total annual release of CO_2 will be by years 2050, 2075, and 2100. Similarly, determine the anticipated total national contributions to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification & other problems by years 2050, 2075 and 2100.

(4) Implementation – Determine how the best practical integrated systems can be successfully implemented by years 2050, 2975 and 2100.

(5) National Action Plans – Once successful best practical integrated systems are developed, prepare National Action Plans to implement the best practical integrated systems by years 2050, 2975 and 2100.

(6) Internal Reporting – Prepare summary progress reports quarterly (every 3 months) that include results from the three People's Projects, and share with all national team members, with the Outreach Program, and with the other nations within the region. Share technology assessments from People's Project 3 with those who fund academic research to maximize the likelihood of achieving rapid commercialization of the most effective and promising technologies needed to solve global warming.

(7) Interfacing – Interface with the facilitators of the Outreach Program to obtain good ideas to overcome global warming, to assist in pilot testing solution options, and to share Global Solutions Program results with States, local communities and industries. Receive quarterly Outreach Program reports and distribute to the GSP teams.

(8) R&D Options – Repeat Work Units (1) through (5) above to include <u>R&D options</u> evaluated in People's Project 3.

<u>Economics Work Units – National Teams</u>

(1) Baseline – Determine how the cost analyses can be made on a consistent basis.

(2) Estimate the total capital and yearly costs of integrated systems ~~strategy~~ to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.

(3) Interface with the Integration Team to arrive at best practical integrated systems that balance technical, economic and social/political factors and assist in preparing National Action Plans.

(4) Identify how these costs can funded and determine the affordability and barriers of paying these costs.

(5) Determine how the economic barriers can be overcome to successfully achieve the best practical integrated systems.

(6) Provide economic assessment results to the Integration Team quarterly (every 3 months).

Social/Political Work Units – National Teams

(1) Interface with the Outreach Program to obtain State, local community and industry evaluations of social/political acceptability for each option considered in Project 1, 2 and 3.

(2) Estimate the social/political acceptability and barriers of integrated systems to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.

(3) Interface with the Integration Team to arrive at best practical integrated systems that balance technical, economic and social/political factors and assist in preparing National Action Plans.

(4) Determine how social/political barriers can be overcome to successfully achieve the best practical integrated systems.

(5) Provide social/political assessment results to the Integration Team quarterly (every 3 months).

National & International WPA Training and GSOP Orientation Work Units – National Team

(1) Train national and international GSOP participants on the WPA and orient them on the GSOP and how the WPA is utilized within the programs. Serve as a national and international focal point to answer questions about the WPA and GSOP.

Coordination, Integration & Internal Reporting Work Units – Regional Teams (National Team Participating)

(1) Based on the National Action Plans within each region, determine what the total annual release of CO_2 will be for each region by the by years 2050, 2075, and 2100.

(2) Based on the National Action Plans within each region, determine the anticipated total national contributions for each region to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.

(3) Combine the National Action Plans into a Regional Action Plan that includes the above technical evaluations and the economic and social/political evaluations.

(4) Determine how the Regional Action Plan can be successfully implemented.

(5) Prepare internal summary progress reports quarterly (every 3 months) for each Region and share with all nations within the Region and among the regions of the world.

(6) Serve as a National POC to coordinate with the Regional Teams.

Economics Work Units – Regional Teams (National Team Participating)

(1) Based on the National Action Plans within each region, estimate the total anticipated capital and yearly costs for each region to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.

(2) Identify how these costs can be paid for and determine the regional affordability and barriers of paying these costs.

(3) Determine how the economic barriers can be overcome to successfully implement the Regional Action Plans.

(4) Assist the Regional Integration and Reporting team to develop the Regional Action Plans.

(5) Provide economic assessment results for the region to the to the Regional Integration Team quarterly (every 3 months).

Social/Political Work Units – Regional Teams (National Teams Participating)

(1) Based on National Action Plans within each region, estimate the anticipated social/political acceptability and barriers for each region to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.
(2) Determine how these barriers can be overcome to successfully implement the Regional Action Plans.
(3) Assist the Regional Integration and Reporting team to develop the Regional Action Plans.
(4) Provide social/political assessment results for the region to the to the Regional Integration Team quarterly (every 3 months).

Coordination, Integration & Internal Reporting Work Units – Global Teams (National Teams Participating)

(1) Based on the Regional Action Plans, determine what the global annual release of CO_2 will be by years 2050, 2075, and 2100.
(2) Based on the Regional Action Plans, determine the total anticipated global contributions to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.
(3) Based on implementing the Regional Action Plans, project global conditions with respect to CO_2 atmospheric levels, global average temperatures, ocean levels, evacuation areas and populations, severe weather conditions, ocean acidification and other problems by the years 2050, 2075, and 2100.
(4) If these conditions are not acceptable, identify additional available approaches that can be taken to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075 and 2100.
(5) Repeat national, regional and global assessments with these additional and/or more intense available approaches in order to meet the above goals and achieve acceptable conditions.
(6) If acceptable conditions cannot be achieved using available approaches, then identify key technical barriers to successfully meeting the above goals and achieve acceptable conditions by years 2050, 2075 and 2100.
(7) Identify technologies in R&D (People's Project 3) that can overcome these key technical barriers and prioritize these technologies.
(8) Repeat national, regional and global assessments with additional and/more intense available approaches plus the prioritized R&D technologies from People's Project 3 in order to meet the above goals and achieve acceptable conditions by years 2050, 2075 and 2100.
(9) Prepare Global Action Plans to successfully meet the above goals and achieve acceptable conditions by years 2050, 2075 and 2100.
(10) Determine how the Global Action Plans can be successfully implemented.

(11) Prepare internal summary progress reports quarterly (every 3 months) for the international Global teams and share with each Region and with all participating nations.
(12) Serve as a National POC to coordinate with the Regional Teams.

Economics Work Units – Global Teams (National Teams Participating)
(1) Based on the Regional Action Plans, estimate the anticipated total global capital and yearly costs to successfully halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems on a global basis by years 2050, 2075, and 2100.
(2) Identify how these costs can be paid for and determine the global affordability and barriers of paying these costs.
(3) Determine how the economic barriers can be overcome to successfully achieve the Global Action Plans.
(4) Assist the Regional Integration and Reporting team to develop the Global Action Plans.
(5) Provide global economic assessment results to the to the Global and Regional Integration Teams quarterly (every 3 months).

Social/Political Work Units – Global Teams (National Teams Participating)
(1) Based on the Regional Action Plans, estimate the anticipated global social/political acceptability and barriers to successfully halt the release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and addressing ocean acidification & other problems by years 2050, 2075, and 2100.
(2) Determine how these barriers can be overcome to successfully implement the Global Action Plans.
(3) Assist the Regional Integration and Reporting team to develop the Global Action Plans.
(4) Provide global social/political assessment results to the to the Global and Regional Integration Teams quarterly (every 3 months).

People's Project 2. Stabilize and Adjust the Earth's Energy Balance, and address ocean Acidification and Other Problems

Project 2 Goals

Project Goal: Identify and evaluate options to stabilize the earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification and other problems by years 2050, 2075, and 2100.

End-State Goal: Best practical approaches are in place and functioning successfully to stabilize the earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification and other problems.

Project 2. Problem Elements (Questions and Barriers)

Organization Problem Elements – National & Global Teams
(1) How best to select, orient, organize and facilitate national teams and sub-teams to accomplish People's Projects 2?
(2) How best to select, orient, organize and facilitate global teams and sub-teams to accomplish People's Projects 2?

Standardization and Information Technology Problem Elements – Addressed in People's Project 1

Technical Problem Elements – Global Teams (National Teams Participating)

Stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions by 2050, 2075 and 2100 Problem Elements – Global Teams
(1) What are the available, proven options to meet these Project 2 goals and what are the standardized technical evaluation criteria that each option must be evaluated against? What are the results of evaluating each option against these criteria?

Address ocean acidification & other problems Problem Elements – Global Teams
(1) What are the available, proven options to meet these Project 2 goals for ocean acidification and methane release and what are the standardized technical evaluation criteria that each option must be evaluated against? What are the results of evaluating each option against these criteria?

Internal Reporting & Coordination Problem Elements – Global Teams (National Teams Participating)
(1) How best to assemble results from global teams working on each option, to prepare internal summary progress reports every 3 months and to hare reports with all participating nations and regions? How can these efforts and teams be coordinated?

Integration Problem Element – Addressed in People's Project 1

Economics Problem Elements – Addressed in People's Project 1

Social/Political Problem Elements – Addressed in People's Project 1

Project 2 Solution Work Units (Options & Action)

Organization Work Units – National & Global Teams
(1) Project 2 Core Team: Select, orient, organize and facilitate national teams and sub-teams to accomplish People's Projects 2.
(2) Organize and support global teams to analyze different options to stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification & other problems by years 2050, 2075, and 2100.

Standardization and Information Technology Work Units – Addressed in People's Project 1

Technical Work Units – Global Teams (National Teams Participating)

Stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions by 2050, 2075 and 2100 Work Units – Global

(1) Identify available, proven options for each category listed below. Consider the attached partial list of options as a starting point and survey nationally and internationally for additional categories and options to meet above objectives. Analyze each option on the attached technical evaluation criteria. Seek out and engage with subject matter experts in government, industry, universities and climate action groups to obtain factual information and data to enable your assessments.

Direct CO_2 removal and sequestering
Ocean fertilization
Restore ecosystems
Agriculture practices
Direct CO_2 removal
Solar blocking atmospheric based
Solar blocking space-based
Alter surface albedo

Address ocean acidification & *other problems work units – Global Teams (National Tams Participating)*

(1) Identify available, proven options to resolve each problem listed below. Consider the attached partial list of options as a starting point and survey nationally and internationally for additional categories and options to meet above objectives. Analyze each option on the attached technical evaluation criteria. Seek out and engage with subject matter experts in government, industry, universities and climate action groups to obtain factual information and data to enable your assessments.

Ocean acidification
Methane release
Refrigeration release

Internal Reporting & Coordination Work Units – Global Teams (National Tams Participating)

(1) Assemble results from international teams working on each option and prepare internal summary progress reports every 3 months. Share reports with all participating nations and regions. Serve as a National POC for coordinating Project 2 efforts.

Integration Work Units – Addressed in People's Project 1

Economics Work Units – Addressed in People's Project 1

Social/Political Work Units – Addressed in People's Project 1

People's Project 3. Climate Monitoring, Modeling & Projections, and Advanced Technologies

Project 3 Goals

Project Goal: Identify ways to accurately monitor and model the Earth's energy and CO_2 balances and to project future conditions. Identify, evaluate and prioritize technologies currently in R&D to meet the objectives of People's Projects 1 and 2. Support and promote international cooperation to test and develop best approaches.

End-State Goal: The Earth's energy and CO_2 balances are accurately monitored and future conditions are predicted with confidence. Advanced technologies are prioritized and accelerated to greatly assist to successfully overcome global warming.

Project 3 Problem Elements (Questions and Barriers)

Organization Problem Elements – National & Global Teams
(1) How best to select, orient, organize and facilitate national teams and sub-teams to accomplish People's Projects 3?
(2) How best to select, orient, organize and facilitate global teams and sub-teams to accomplish People's Projects 3?

Standardization and Information Technology Problem Elements – Addressed in People's Project 1
Technical Problem Elements – Global Teams (National Tams Participating)

Climate Monitoring, Models and Future Conditions Problem Elements – Global Teams (National Teams Participating)
(1) What are the ways and available data to monitor the Earth's energy and CO_2 balances?
(2) Can simplified engineering models of the earth's energy and CO_2 balances be developed using available monitoring data and other existing models?
(3) How can each option's contributions to stabilize and adjust the Earth's energy and CO_2 balances be evaluated?
(4) Engineering projections of future conditions based on implementing options from People's Projects 1, 2 and 3 are needed for evaluations. How do these results compare to other predictive climate models?

Advanced Technologies in R&D Problem Elements – Global Teams (National Teams Participating)
(1) What are the advanced options currently in R&D to halt the net release of atmospheric CO_2, to adapt to unavoidable climate change impacts, to stabilize and adjust the Earth's energy balance to halt global warming and return to prior conditions, and to address ocean acidification and other problems?

(2) How can these technologies be prioritized to help focus ongoing and future R&D and provide support to these developments?

Internal Reporting & Coordination Problem Elements – Global Teams (National Teams Participating)
(1) How best to assemble results from global teams working on each option, to prepare internal summary progress reports every 3 months and to hare reports with all participating nations and regions? How can these efforts and teams be coordinated?

Integration Problem Elements – Addressed in People's Project 1

Economics Problem Elements – Addressed in People's Project 1

Social/Political Problem Elements – Addressed in People's Project 1

Project 3 Solution Work Units (Options & Action)

Organization Work Units – National & Global Teams
(1) Project 3 Core Team: Select, orient, organize and facilitate national teams and sub-teams to accomplish People's Projects 3.
(2) Organize and support global teams to analyze different options currently in R&D to halt the net release of atmospheric CO_2, adapt to ongoing climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification & other problems by years 2050, 2075 and 2100.

Standardization and Information Technology Work Units – Addressed in People's Project 1

Technical Work Units – Global Teams (National Teams Participating)

Climate Monitoring, Models and Future Conditions Work Units – Global Teams (National Teams Participating)

(1) Identify ways and available data to monitor the Earth's energy and CO_2 balances.
(2) Develop engineering models of the earth's energy and CO_2 balances using available monitoring data and other existing models.
(3) Develop ways to evaluate each option's contributions to stabilize and adjust the Earth's energy and CO_2 balances.
(4) Develop engineering projections of future conditions based on results from People's Projects 1,2 and 3. Compare results to other predictive climate models.

Advanced Technologies in R&D Work Units – Global Teams (National Teams Participating)

(1) Identify advanced options currently in R&D for each category listed below. Consider the attached partial list of options as a starting point and survey nationally and internationally for additional categories and options to meet above objectives. Analyze each option on the attached technical evaluation criteria. Seek out and engage with subject matter experts in government,

industry, universities and climate action groups to obtain factual information and data to enable your assessments.

Halt the net release of atmospheric CO_2

Clean Energy
Energy Storage
Winter Energy Sources
Energy Conservation
Social Actions
Industrial Carbon Capture & Sequestering

Adapt to unavoidable climate change impacts

Social actions

Stabilize and adjust the Earth's energy balance to halt global warming and return to prior conditions

CO_2 removal and sequestering:
Ocean fertilization
Restore ecosystems
Agriculture practices
Direct CO_2 removal
Solar blocking atmospheric based
Solar blocking space-based
Alter surface albedo

Address ocean acidification & *other problems*

Ocean acidification
Methane release

(2) Prioritize the energy and stabilization technologies based on technical evaluations to help focus ongoing and future R&D and provide support to these developments.

Internal Reporting & Coordination Work Units – Global Teams (National Teams Participating)

(1) Assemble results from global teams working on each option and prepare internal summary progress reports every 3 months. Share reports with all participating nations and regions. Serve as a National POC for coordinating Project 3 efforts.

Integration Work Units – Addressed in People's Project 1

Economics Work Units – Addressed in People's Project 1

Social/Political Work Units – Addressed in People's Project 1

Outreach Program – Problem Diagram

The Outreach Program will provide teams of engineers in each State who will directly interface with State, local community and industry initiatives to overcome global warming. Each State outreach team will have two full-time and 20 part-time engineers to provide on-the-ground support and advice. This support will evolve based on the needs of each State and its local communities and industries. The outreach will also link the State and local initiatives with the national and international GSP to generate a two-way flow of good ideas, results and assistance.

Program Goals

Program Goal: Provide engineering support and advice to States, local communities and industries that are taking action on clean energy, CO_2 reductions, improved efficiencies, adaptations and other global warming solutions. Interface closely with the Global Solutions Program to provide a two-way flow of information and collaboration between local, national and international levels to achieve a broad and powerful focusing of many minds. Encourage other nations to establish similar Outreach Programs to ultimately arrive at feasible and effective mixes of climate solutions for each Nation's States, local communities and industries.

End-State Goal: Best practical approaches are in place and functioning successfully to halt the net release of CO_2, cope with unavoidable climate-change impacts, stabilize the Earth's energy balance to halt global warming, adjust the Earth's energy balance to return to prior conditions, and address ocean acidification and other problems.

Outreach Program Problem Elements (Questions and Barriers)

Organization Problem Elements – National Team

(1) How best to select, orient, organize and facilitate national teams and sub-teams to accomplish the Outreach Program?
(2) How best to encourage other nations to establish similar Outreach Programs?
(3) How best to become aware of other national climate action groups and to exchange information?

Outreach Problem Elements – State and Local Teams

(1) How best to interface with State, local communities and industries to become aware of their groups and actions on global warming?
(2) How best to provide engineering assistance to States, local communities and industry on their climate change efforts?
(3) How best to inform States, local communities and industry on the GSOP?
(4) How best to inform and explain GSOP results to States, local communities and industry?
(5) How best to exchange good ideas between the GSOP and States, local communities and industry?

(6) How best to plan and carry out pilot testing of promising options?
(7) How best to interface with States, local communities and industry for active two-way communications?

Internal Reporting Problem Elements – National, State and Local Teams

(1) How can national and international project participants be kept informed of Outreach Program progress and results?
(2) What information needs to be exchanged between the Outreach Program and the Global Solutions Program and how is this to be accomplished?

Social/Political Problem Elements – State and Local Teams

(1) How best to gain State, local communities and industries assistance to provide social/political evaluations of GSP options?

Outreach Program Solution Work Units (Options & Actions)

Organization Work Units – National Team

(1) Recruit, orient, organize and facilitate and State teams to accomplish the Outreach Program.
(2) In concert with the Project 1 Global Outreach Team, encourage other nations to establish similar Outreach Programs to ultimately arrive at feasible and effective mixes of climate solutions for each Nation and its States, local communities and industries.
(3) Interface with national climate action groups to inform them of the GSOP, offer to keep them updated on results, and ask what factual information they can provide on options to overcome global warming.

Outreach Work Units – State and Local Teams

(1) Many States, local communities and industries are concerned and taking action on global warming. State teams will interface with these groups and their efforts.
(2) State teams will engage with State, local community and industry to support the development and implementation of their climate action plans by providing engineering support and advice.
(3) State teams will offer awareness training on the Global Solutions Program and the wicked-problem approach, and will explain how the Global Solutions Program (GSP) and the Outreach Program will work together to successfully overcome the threat of global warming.
(4) State teams will provide and explain results from the GSP to keep all involved State, local communities and industries well informed, and to assist them in implementation of the best GSP options.
(5) State teams will document good ideas from the State, local communities and industry, including their evaluation and testing of proven and new technologies. They will provide this information to the GSP Project 1 Integration Team for consideration.
(6) State teams will work with States, local communities and industries to pilot test promising options from the GSP. The teams will provide engineering assistance in support of pilot testing.

(7) State teams will interface with local and State level climate action groups to inform them of the GSOP, offer to keep them updated on results, and ask what factual information they can provide on options to overcome global warming.

Internal Reporting Work Units – National, State and Local

(1) National. Assemble the internal summary reports from each State and prepare an Outreach Program summary report once a quarter. Provide these to the GSP Integration & Reporting Team. These reports should include a catalogue of State, local communities, industries, and within State climate action groups working on global warming, their POC and contact information, a summary of their efforts, and types of factual information they can provide. The report will also include similar information on national climate action groups.

(2) State and Local. Prepare Outreach Program internal summary reports for each State quarterly and provide to the National team. The reports should summarize good ideas, social/political evaluations of GSP options, State, local community, industry and climate action group initiatives and results, and pilot testing plans and results. The reports should include a catalogue State, local communities, industries, and within State climate action groups working on global warming, their POC and contact information, a summary of their efforts, and the types of factual information they can provide.

Social/Political Work Units – State and Local Teams

(1) In cooperation with Project 1 Social/Political Work Unit's team, State teams will request State, local community and industry assistance with evaluation of the social/political factors for climate solution options under study by the GSP. They will provide these evaluations to the GSP Project 1 Social/Political Work Unit's team.

Attachment 1

Partial List of GSOP Options

The GSOP options listed here are taken from the following references:

a. *Beyond Carbon Neutral: How We Fix the Climate Crisis Now*, authored by Samuel M. Goodman, PhD, New Degree Press, Copyright © 2021, which provides an integrated selection of options that can be immediately implemented to overcome global warming. (BCN p #)

b. *Drawdown, The Most Comprehensive Plan Ever Produced to Reverse Global Warming*, edited by Paul Hawken, Penguin Books, (2017), which provides an extensive list of options, both available now and others in R&D for confronting global warming. (DD p #)

e. *Climate Restoration, The Only Future That Will Sustain the Human Race*, authored by Peter Fiekowsky with Carole Douglis, Rivertowns Books, 2022. (CR p #)

d. *Speed* & *Scale*, authored by John Doerr, Portfolio/Penguin (2021). (S&S p #)

People's Project 1. Halt release of CO_2 & Adapt to Climate Change

Halt net release of CO2

Clean energy

1. Electric vehicles. A switch to Electric vehicles will reduce fossil fuel use, but we must decarbonize the power grid to make a difference. (BCN p 21).
2. Electric Vehicles to reduce carbon dioxide release. (DD p 142)
3. Electric Bikes are a rage in China and reduce energy requirements. (DD p 146)
4. Hybrid Cars improve fuel efficiency with a combination of electric and gas/diesel engines. (DD p 148)
5. Nuclear. Continue operating existing nuclear facilities and reprocess our spent fuel to prolong their operation. (BCN p 38). (DD p 18)
6. Photovoltaics. Use photovoltaics to convert energy contained in sunlight into electricity. (BCN p 52)
7. Solar thermal. Harvest sunlight to generate steam and turn a turbine and generate electricity. A solar thermal plant is mostly composed of massive mirrors (BCN p 56). (DD p 14)
8. Solar farms. Large solar farm installations in the desert will be solar thermal plants with energy storage capabilities generate electricity during the day and night (BCN p 61). (DD p 8)
9. Distributed solar. Spread individual solar panels over a large area to generate the same amount of power. The panels are light enough to be placed on buildings (BCN p 63). (DD p 10)
10. Onshore Wind Farms. Generate electricity with the Great Plains being a prime location because of its relatively fast and consistent winds. Bigger blades and turbines can convert that energy more efficiently (BCN p 71). (DD p 2)

11. Offshore Wind Farms. Similar to onshore wind farms for generating electricity. The towers and blades have the same shape, and they're arranged in lines spread out over a large area. The towers are attached to the seafloor (BCN p 73). (DD p 2)
12. Micro Wind for small local electric needs. (DD p23)
13. Fresh water hydropower. Resources are dams that already power a substantial portion of our grid. Some dams were never electrified and could be easily upgraded. The older fleet could be recapitalized with better generators and turbines (BCN p 82). (DD p 27)
14. Salt water energy. Tidal barrages require an entire shoreline area would be walled in, with a gap every so often with a rotor, not unlike a wide-area dam. Installing sub-surface turbines to capture the energy of tides is another option still in R&D (BCN p 85) (DD p 12). The most commonly presented way for harnessing waves puts the generators out from the shore on the ocean's surface in the form of floating pontoons or buoys anchored to the seafloor and connect to the shore by undersea cables. Test cases were made to prove this approach, but none are scaled to full grid-scale implementation. (BCN p 88)
15. Geothermal. Heat is draw from within the earth. That heat is used to create steam and turn a turbine and generator to make electricity with constant production. Alternately, marginal geothermal regions can add to our energy to replace the majority of traditional furnaces and low-temperature industrial applications continuously and without the need for additional storage
(BCN p 95). (DD p 6)
16. Upgrade the US electrical transmission system. The system requires upgrading to improve reliability, and to handle greater electricity demands and altered electrical sources, i.e., renewables. 1. Grid Flexibility to deal with intermittent and on-demand energy supplies is an aspect. (DD p 30)
17. Ammonia is being considered as an alternate to bunker fuels for transport ships. (CR p 67)
18. Electrify transportation. (S&S p 1)
19. Decarbonize the Grid. (S&S p 29)

Energy Storage (Necessary as we rely on intermittent and non-dispatchable renewable sources for the bulk of our transition. (BCN p 105)
1. Batteries. Rechargeable batteries for energy storage have improved rapidly over the past several decades. They include lithium-ion, nickel-cadmium (NiCd) and nickel-metal hydride (NiMH) (BCN p 106). (DD p 34)
2. Thermal Storage. Molten salts from solar thermal power generation are pumped into insulated tanks while other power sources feed the grid. When they're needed, those salts are used to generate steam to make electricity. Excess electricity can be used to heat salts to later produce steam and generate electricity. (BCN p 110) (DD p 32)
3. Pumped hydropower. Water is moved uphill to artificially create the conditions for hydropower. When there is excess energy on the grid, water is pumped to a reservoir at a high elevation from a lower reservoir. (BCN p 113) (DD p 32)
4. Compressed air. Compressed air is stored underground until it is passed over a turbine when needed to generate electricity. The main problem is finding appropriate locations. (BCN p 116)
5. Multi-Layered Energy Storage. Will include thermal storage augmented by pumped hydropower, compressed air and a small amount of NiCd batteries are options. (BCN p 117)
6. A smart grid is an interconnected system where power-consuming devices talk to utilities over the Internet to control some of their functionality. However, there is no way such a system would be secure enough not to threaten the grid and everything attached to it. (BCN p 119), (DD p 5)

Winter energy sources (Renewable energy is, on the whole, less plentiful in winter and must be dealt with. (BCN p 123)
1. Wood. Burning wood creates a complete cycle where no net carbon is released, hence *carbon neutral*. The bottleneck for harvesting wood is the amount of land we dedicate to growing trees. Meeting just 1 percent of our yearly energy needs would require a forest approaching the size of South Carolina. A similar area of solar panels would provide 22 percent of all our energy needs (BCN p 124). (DD p 16)
2. Ethanol. Grain alcohol, is another carbon neutral biofuel we derive from plant matter. However, it provides substantially less energy than wood per acre. (BCN p 126)
3. Biofuels& synthetic fuels. Jet fuels must be either fossil fuels or a carbon neutral option biofuel and synthetic fuels. Synthetic fuels can be produced using the Fischer-Tropsch process with energy from wind and solar. (BCN p127, 129)
4. Trash gas. Microbes eat organic trash and produce methane as a byproduct, which could help meet seasonal energy shortfalls (BCN p 313). (DD p 26)
5. Waste-to-Energy to better deal with waste, while still releasing carbon dioxide. (DD p 28)

Energy conservation
1. Reduce shipping. Reduce the shipping industry by cutting back on globalization and increase domestic manufacturing to reduce energy needs. (BCN p 152)
2. Long-lasting goods. A way to conserve energy use is to require manufacturers to only produce long-lasting goods (BCN p 183). 24. The need for jet fuel could be cut by reducing air travel through cultural change. (BCN p 190)
3. Cogeneration of electricity and heat for buildings. (DD p22)
4. Solar Water to heat water for domestic use. (DD p 36)
5. Mass Transit use may decline but bus rapid transit is popular in S. America. (DD p 136)
6. High-Speed Rail up to 270 mph can greatly reduce carbon dioxide emissions but are costly. (DD p 138)
7. Ship's fuel efficiency can be increased improved designs. (DD p 140)
8. Ride Sharing can expand and reduce energy requirements. (DD p 144)
9. Airplanes can reduce fuel needs with improved designs and on-ground procedures. (DD p 150)
10. Trucks can reduce fuel needs with better designs and operating procedures. (DD p 152)
11. Telepresence can reduce business air travel and unproductive time while saving energy. (DD p 154)
12. Trains fuel efficiencies can be improved with better designs and converting to electric. (DD p 156)
13. Industrial Recycling can be enhanced by mandating extended producer responsibility. (DD p 160)
14. Net Zero buildings designed to conserve energy and use sun radiation. (DD p84)
15. Green roofs with vegetation and cool roofs to reflect sun's energy. (DD p90)
16. LED lighting saves energy. (DD p92)
17. Heat pumps can reduce fuel requirement for heating buildings. (DD p94) New generations of electric heat pumps can further reduce fuel needs. (CR p 65)
18. Smart glass can admit or block sun's radiation to reduce energy requirement for AC, heating. (DD p96)
19. Smart thermostats adjust building temperature to improve energy efficiency. (DD p98)
20. District heating uses central plants for heating and cooling of homes. (DD p99)
21. Insulation can be retrofitted or designed into buildings to reduce energy use. (DD p101)

22. Water distribution can be improved by reducing leaks, saving pumping energy. (DD p104)
23. Building automation can improve energy efficiency. (DD p106
24. Clean up industry. (S&S p 117)
25. Fix Food. (S&S p 63)
26. Protect nature. (S&S p 91)

Social actions

1. Plant-Rich Diet and cut back on eating meat. (DD p 38)
2. Clean Cookstoves to reduce household toxic fumes that kill people and release carbon dioxide. (DD p 44)
3. Women Small Holders provides more resources and improves productivity of women farmers. (DD p 76)
4. Family Planning requires providing free access to contraception plus education. (DD p 78) Restoring population to sustainable levels through small families will help greatly in overcoming global warming and other sustainability issues. (CR p 162)
5. Educating Girls makes them better stewards with fewer children. (DD p 80)
6. Household Recycling can cut energy needs by using recycled materials for virgin feedstock. (DD p 158)
7. Water Saving – Home by using low-flow taps and shower-heads can cut carbon dioxide emissions. (DD p 170)
8. Walkable Cities to conserve transportation energy. (DD p86)
9. Bike Infrastructure to increase bike usage and reduce energy needs. (DD p88)

Industrial carbon capture & sequestering

1. Capture, separate and compress CO2 emissions from power plants and large industrial plants before they enter the atmosphere using additional equipment at the tail end of industrial processes. However, capturing and sequestering the emissions from fossil fuel sources will only delay the needed transition and will do nothing about the carbon already in the atmosphere. (BCN p 176). Several commercially feasible technologies have been demonstrated. Reduction in power plant efficiency due to added energy requirement needs to be considered.
2. Store compressed CO_2 in underground geological formations.
3. Inject CO_2 into existing oil fields to enhance oil recovery. (This is not carbon neutral if recovered oil is burned and CO_2 emitted to atmosphere).
4. Remove carbon. (S&C p 139)

Adapt to unavoidable climate change impacts

1. Social actions and other options to be determined.

People's Project 2. Stabilize and Adjust the Earth's Balance and Address Ocean Acidification and Other Problems

Stabilize the Earth's energy balance to halt warming and adjust the Earth's energy system to return to prior conditions

Ocean fertilization and cultures

1. Ocean fertilization. Fertilizing the oceans with nitrogen fertilizer or iron as chloride (FeCl2) could remove carbon dioxide from the air. (BCN p 144) Seaweed and marine permaculture can also remove great quantities of atmospheric CO_2. (CR p 98) Fertilizing the ocean with iron can restore ocean health while removing great quantities of atmospheric CO_2. (CR p 115)

Restore ecosystems

1. Farmland Restoration where land has been farmed out and no longer productive. (DD p 41)
2. Mangroves and marshes. Restore these interfaces between the ocean and land, to store large quantities of carbon dioxide without further effort. Layers upon layers build up over time, removing substantial quantities of carbon dioxide from the atmosphere. (BCN p 148)
3. Ocean meadows. Fostering underwater meadows of seagrass can remove atmospheric carbon dioxide. BCN (p 151)
4. Swamps and bogs. Protect and restore swamps and bogs to take out and store vast quantities of atmospheric carbon. (BCN p 158)
5. Peatlands sequester carbon and must be preserved. (DD p 122)
6. Forests. Expand Forests to rapidly draw down atmospheric carbon. (BCN p 161)
7. Temperate Forest protection and restoration reduces carbon release and sequesters carbon. (DD p 128)
8. Afforestation involves planting trees on land previously cleared in natural diverse varieties. (DD p 132)
9. Grassland. Protect and restore grassland to sequester carbon. (BCN p 163)
10. Forest protection: stop clearing of old growth forest and other forest land. (DD p108)
11. Coastal wetlands sequester carbon and mitigate storm surges, must be protected. (DD p112)
12. Tropical forests continue to be cleared and must be protected. (DD p114)
13. Peatlands sequester carbon and must be preserved. (DD p122)

Agricultural practices

1. Change farming practices to better sequester carbon, even during cultivation, and to preserve soil health through no-till planting or the use of cover crops to hold soils together. (BCN p 166)
2. Change our diets away from farm-raised animals and expand vegetable proteins to reduce the amount of farm land and use it to meadows and forests to sequester carbon. (BCN p 168)
3. Bamboo grows fast, sequesters carbon and can be grown on degraded land. (DD p117)
4. Agro-forestry nurtures trees alongside crops. (DD p118)
5. Perennial Biomass yields useful products year after year without replanting. (DD p121)
6. Indigenous Peoples' Land Management practices conserve forest, cut carbon release. (DD p124)
7. Reduced Food Waste among many players in the food chain. (DD p 42)
8. Multi-strata Agroforestry to improve crop diversity and sustain soils. (DD p 46)
9. Improved Rice Cultivation to reduce methane release. (DD p 48)
10. Silvo-pasture to integrate trees, pasture for livestock. (DD p 50)
11. Regenerative Agriculture to restore degraded land. (DD p 54)
12. Nutrient Management to reduce run off and waste. (DD p 56)
13. Tree Intercropping uses diversity to improve soil health and sequester carbon. (DD p 58)
14. Conversation Agriculture avoids tilling, helps to retain moisture and improve the soil. (DD p 60)
15. Composting to convert organic matter into stable soil carbon and improve the soil. (DD p 62)
16. Biochar is produced by burning organic waste under a layer of soil and builds soil carbon content. (DD p 64)
17. Tropical Staple Trees produce food products annually without replanting. (DD p 66)

18.Farmland Irrigation techniques can reduce energy and improve crop yields with drip or spray. (DD p 68)
19. Managed Grazing simulates natural grazing with animals moving from one area to another. (DD p 72)
20. Agro-forestry nurtures trees alongside of crops to yield many advantages and is spreading. (DD p 118)
21. Perennial Biomass yields useful products year after year without replanting saving energy. (DD p 121)
22. Indigenous Peoples' Land Management practices conserve forests and avoid carbon release. (DD p 124)

Direct CO_2 removal & sequestering

1. Direct air capture. Directly capture carbon dioxide from the atmosphere by freezing it out of the air or use chemical capture techniques. The downside is energy requirement. (BCN p 174)
2. Capture and sequester. Burn new trees, shrubs, and grasses and capture the resulting concentrated stream of carbon dioxide for sequestration. (BCN p 176)
3. Store carbon dioxide. Store captured carbon dioxide by pumping it underground at a site with the appropriate geology. Tests are still underway to prove the it as a permanent solution. Mineralization is a process that can sequester carbon within certain kinds of rock to form calcium carbonate. It is a slow process as shown by several small test cases. (BCN p 177)
4. Building with carbon. Building with laminated timber would be another way to sequester carbon (BCN p 182). 75. Alternative Cement using fly ash from burning coal can reduce carbon dioxide release. (DD p 162)
5. Recycling Paper releases less carbon dioxide that using fresh fiber from trees. (DD p 166)78 Bioplastic can reduce emissions and sequester carbon. (DD p 168)
6. Removing CO_2 from power-plant exhaust and converting it into synthetic limestone is a demonstrated process and offers a way to sequester CO_2 that would otherwise go into the atmosphere. The process can also be used to sequester CO_2 from direct air capture plans. (CR p 83)

Solar blocking

1. Atmosphere & space-based. One option to reverse climate change is to add specific chemicals, such as sulfuric acid or hydrogen sulfide, into the atmosphere to reflect sunlight back into space. Placing mirrors in space is another option. Neither, approach will address ocean acidification. (BCN p 187)

Alter surface albedo

Ocean acidification and other problems

Ocean acidification

Methane release

1. Landfill methane can be collected and burned for electricity (much lower warming potential). (DD p100)

Refrigeration release

1. Refrigeration releases of CFC refrigerants reduced and alternatives for CFCs found. (DD p 164)

People's Project 3. Advanced technologies (currently in R&D)

Halt net release of CO_2

Clean energy

1. New energy sources. Energy sources for carbon capture and sequestration may include new nuclear capacity that is still in R&D. (BCN p 181) Small modular nuclear reactors (SMRs) that have many safety and fuel use advantages over today's nuclear power plants are under intense development in the US, Canada and other countries.
2. Artificial Leaf to produce synthetic fuel from sunshine, water, carbon dioxide and bacteria. (DD p 182)
3. Solid-State Wave Energy convert kinetic energy of waves to electricity. (DD p 187)
4. Ocean Farming with sea weeds and shell fish removes nitrogen and mercury and gives biofuels. (DD p 206)
5. Smart Grids communicate between suppliers and consumers to improve efficiencies and deal. (DD p 209)
6. Cold fusion using quantum confinement or lattice confinement is now showing promise as an energy source. (CR p 68
7. Illinois Clean Fuels has a process to convert municipal solid waste into jet fuel. (CR p 66) Carbon Engineering is developing sustainable aviation fuel with its "air to fuels" process, which filters CO_2 from air and combine it with hydrogen to form synthetic aviation fuel. (CR p 66)

Energy storage

1. Iron-air batteries may provide greatly expanded levels of electricity storage, even at utility-scale levels. (CR p 63)
2. Flow batteries may also provide utility-scale levels by storing liquid electrolytes, vanadium or iron, in tanks. (CR p 64)

Winter energy sources

Energy conservation

1. Autonomous Vehicles gain fuel efficiency by following each other closely. (DD p 184)
2. Living Buildings Challenge is as standard for sustainable buildings. (DD p 188)
3. Smart Highways will recharge electric vehicles as they pass and have photovoltaic surfaces. (DD p 196)
4. Hyperloop involves passing pods of people or cargo through a tunnel as high speeds. (DD p 198)

Social actions

Industrial carbon capture & sequestering

1. Improve adsorption efficiency of MOFs (metal-organic frameworks) to reduce scale and cost.
2. Develop viable commercial chemistries for converting CO_2 to hydrocarbons or building materials.

Adapt to unavoidable climate change impacts

Stabilize the Earth's energy system to halt warming and adjust the Earth's energy system to return to prior conditions

Ocean fertilization

1. Ocean fertilization. Fertilizing the oceans with nitrogen fertilizer or iron as chloride (FeCl2) could remove carbon dioxide from the air. (BCN p 144) Seaweed and marine permaculture can also remove great quantities of atmospheric CO_2. (CR p 98) Fertilizing the ocean with iron can restore ocean health while removing great quantities of atmospheric CO_2. (CR p 115)

Restore ecosystems

1. Repopulating the Mammoth Steppe by converting it back to grasslands with wild herbivores. (DD p 172)

Agriculture practices

1. Pasture Cropping involves planting crops in a living perennial pasture without breaking the soil. (DD p 175)
2. Intensive Silvo-pasture mixes grasses, trees, leguminous shrubs and grazing animals. (DD p 181)
3. Microbial Farming uses combinations of microorganisms to fertilize the soil. (DD p 200)
4. Perennial Crops, grains and cereals, and oilseed plants, avoid tilling and sequester carbon. (DD p 203)

Direct CO_2 removal & sequestering

1. Solid carbon. Store solid carbon by converting a concentrated stream of carbon dioxide to solid carbon or carbonates suitable for safe disposal. Ways to do so are currently in R&D. (BCN p 179)
2. Enhanced Weathering of Minerals, olivine, spread on land and shallow water to uptake CO_2. (DD p 176)
3. Marine Permaculture by creating suspended kelp forests. (DD p 178)
4. Direct Air Capture takes carbon dioxide from the air and concentrates it for sequestering. (DD p 192)
5. Industrial Hemp is environmentally superior to cotton and can substitute with processing. (DD p 202)
6. Building with Wood sequesters carbon and avoids CO_2 release from cement manufacture. (DD p 210)
7. React CO2 with hydrogen to produce hydrocarbons useful for chemicals/plastics. This is very difficult chemistry and is still in R&D phase.

Solar blocking atmospheric based

Solar blocking space-based

Alter surface albedo

Address Ocean Acidification and Other problems

Ocean acidification

Methane release

1. A Cow Walks onto a Beach and ate seaweed that improved milk production and reduced methane release. Research is focusing in on red algae to improve digestion and reduce methane. (DD p 2040)
2. Enhanced methane oxidation in the atmosphere can accelerate the removal of methane and reduce concentrations. (CF p 142)

Attachment 2

Technical Evaluation Criteria for Each GSP Option (Both Available & Ones in R&D)

Technical evaluation criteria

- Technical feasibility & technical readiness level.
- Effectiveness in halting the net release of CO_2.
- Effectiveness in stabilizing and adjusting the Earth's energy balance.
- Effectiveness in correcting ocean acidification and other problems.
- Effectiveness in coping with unavoidable climate change impacts.
- Environmental impacts.
- Personnel and community safety.
- Scale, timing and locations of implementation.
- Capital & yearly costs per unit and at scale and timing of implementation.
- Net energy requirements and availability.
- Human, natural, and water resource requirements and availability.

Economic and Social/political evaluation criteria are included in the Problem Diagrams.

Note: These criteria were selected to reach practical, effective results. The integrated systems from the GSP must work when they are implemented just as a bridge, a chemical plant, or a rocket system must work when built.