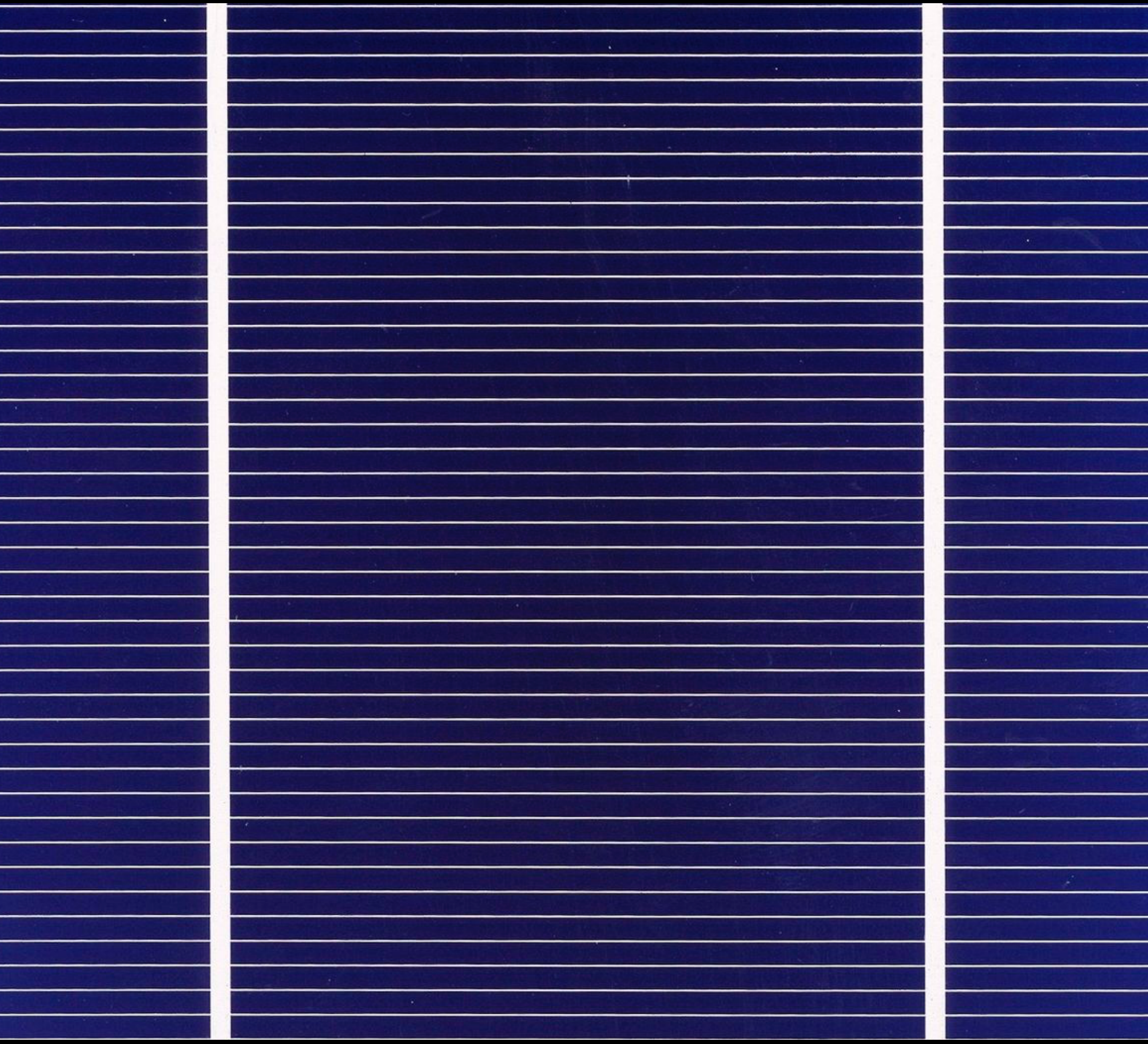
H.R. 4393 | Clean Distributed Energy Grid Integration Act

Action and Implementation Plan for 2017



Columbia University | School of International and Public Affairs

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H.R. 4393 | The Clean Distributed Energy Grid Integration Act: First Year Action and Implementation Plan

Prepared by

ELIZABETH MEDFORD[1], JUDY GOH[2], JOHNATHON A. DE VILLIER, MCKENZIE SCHWARTZ, ALEXEI GITTELSON, LOUISE VENABLES, MAURICIO CHILD, KAI CHEN, ARINA SUSIJO AND SIYU CHEN

[1]*Workshop manager*
[2]*Deputy manager*

Faculty Advisor

LOUISE ROSEN

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Front cover

Close up image of a monocrystalline solar cell typical of distributed solar installations. Adapted from solarmarket.com.

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EXECUTIVE SUMMARY

The United States (U.S.) electricity grid provides power to hundreds of millions of consumers, but it faces many challenges. Between 1995 and 2015, U.S. electricity generation increased from 3.6 to 3.4 billion megawatt-hours (22 percent; EIA 2016a), and generation capacity is projected to increase from 1 million to 1.2 million megawatts (20 percent) between 2015 and 2040 (EIA 2016b). As demand rises, vulnerability to blackouts, fossil fuel dependence, and inefficiency are all growing concerns. However, each of these challenges presents an opportunity for innovation and improvement. The Clean Distributed Energy Grid Integration Act is a bipartisan piece of legislation designed to seize the opportunity to change the way the U.S. produces electricity.

Electricity generation in the United States is currently dominated by centralized large-scale facilities. In recent years we have seen why this situation is problesmatic. For example, in 2012, Superstorm Sandy left millions of people without power for weeks when vital electricity infrastructure failed. The U.S. is heavily reliant on an electricity transmission and distribution network conceived over a century ago. Our aging grid is inefficient, outdated and dependent on fossil fuels like coal and natural gas, the burning of which generates greenhouse gas emissions that contribute to global climate change.

We need a new way of thinking about electricity generation and distribution. Consider an alternative to the status quo described above: the use of clean, distributed generation technology integrated into the main electricity grid. Rooftop solar panels, for example, generate electricity at the consumer site without producing greenhouse gases. The electricity does not have to travel long distances through high-voltage power lines, which vastly reduces transmission and distribution losses. The consumer uses as much electricity from their solar panels as they require, releasing any excess electricity onto the main grid through a two-way-meter. This creates a potential revenue stream for the consumer, and, in the event that the main grid infrastructure fails, the consumer's on-site electricity supply remains unaffected. This example shows that by diversifying electricity generation we can create benefits such as uninterrupted supply and reduced greenhouse gas emissions. The Clean Distributed Energy Grid Integration Act aims to facilitate the transition to a clean, diversified and distributed electricity grid.

Here, we set out an implementation program for the Clean Distributed Energy Grid Integration Act. The program design concentrates on actions that the Department of Energy, as the administrator of the program, will take in the twelve months following enactment. We begin by detailing the background and context of the Act. Next, we explain the program design, organizational structure, staffing plan, budget, performance management system. We conclude by summarizing how the framework we propose will facilitate a material improvement in production and consumption of electricity in the U.S. We have provided working definitions of key terms in Appendix A.

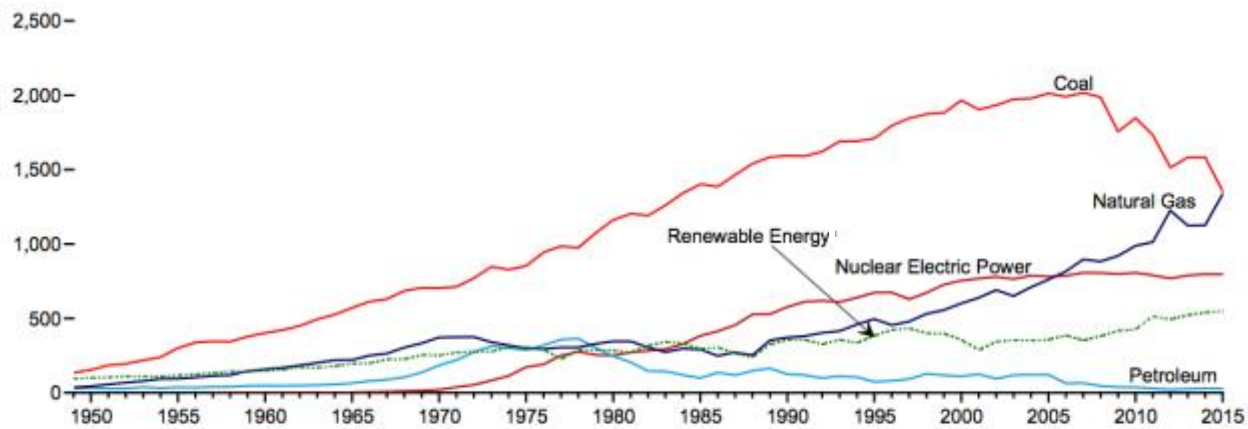

Figure 1 | Fuel consumption for electricity generation in millions of megawatt-hours, 1950 - present. As of 2016, natural gas has surpassed coal as the largest component of the U.S. energy mix. Approximately 15 percent of electricity originates from renewable sources. Data are from the United States Energy Information Administration (2016).

INTRODUCTION

A Brief History of the United States Electricity Grid

When Thomas Edison launched the first commercial electricity grid—a network of infrastructure able to deliver electricity—in Lower Manhattan in 1882, he may not have imagined that much of the United States (U.S.) would apply the same principles on a national scale to power millions of homes, businesses, and public facilities. Edison's original grid served 59 consumers; in its current form, it serves more than 140 million. Falling prices for newer, alternative energy sources such as wind, solar, and natural gas have led to a diversification of energy production. Natural gas recently surpassed coal as the single largest energy source in the U.S, accounting for 34 percent of generated electricity (EIA 2016a; Figure 1). Renewables, which accounted for less than one percent of electricity generation at the turn of the 21st century, now make up more than 15 percent of the national energy mix (EIA 2016a).

Collectively, market forces and changing technologies with high and sometimes variable energy needs strain an outdated grid infrastructure that has not experienced major restructuring in decades (EIA 2016c). The U.S. experiences more blackouts than any other developed nation (Amin 2011): in 2015, electricity providers reported an average interruption duration of 132 minutes (EIA 2016d), in stark contrast to the 12 minute average experienced by consumers in Germany (Hales 2015). In addition, more than two thirds of the energy contained in a typical fuel source is lost during the course of electricity generation, transmission and distribution (Pellegrino et al. 2004), an indication of the inefficiency of what was once a cutting-edge engineering feat. Outages cost U.S. taxpayers billions of dollars every year (Amin 2011), and inefficiency necessitates the over-consumption of fossil fuels to meet consumer

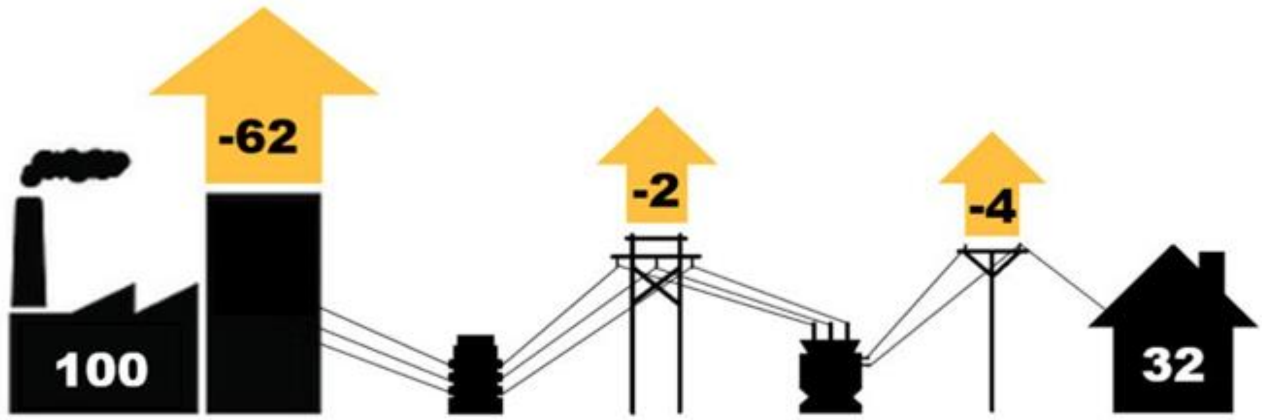

Figure 2 | Centralized, fossil fuel-dependent for electricity generation, transmission and distribution inefficient. Most of the energy lost between the generation site and the consumer is lost during the process of combustion (far left; standardized units); however, the 6 percent lost in the two subsequent steps over the course of a single day would be sufficient to meet the energy needs of 50,000 average United States homes for one year. Data are from the United States Energy Information Administration (2016).

demand—releasing vast amounts of unnecessary greenhouse gases into the atmosphere. The legacy of the patchwork expansion of the U.S. electricity grid is also evident in the fragmentation of its regulatory framework. The national grid is broken into three isolated interconnections that provide electricity to the eastern states, western states, and Texas (EIA 2015), overseen by a complex body of federal and public agencies, as well as public and private utility companies. These stakeholders have a range of values, goals, and incentives that may be in opposition to one another.

Centralized Electricity Generation in the United States

Electricity generation and delivery in the U.S. typically follows a centralized model, where generation facilities burn fuels in a few large, utility-scale power plants (greater than 10 megawatt capacity). These plants are generally sited to optimize operational and transportation costs, often near fossil fuel reserves, transport pipelines, or waterways, rather than strictly according to patterns of consumer demand (NCEP 2004). The centralized model enables energy producers that rely heavily on fossil fuels to take advantage of economies of scale to produce electricity cheaply, but electricity may have to be transmitted over long distances to reach the end consumer. In a traditional coal-fired power plant, 62 percent of the primary energy contained in the fuel source is lost as waste heat during the generation process (Figure 2). Although transmission and distribution are efficient relative to generation, material resistance and friction in electricity lines causes a further 6 percent of generated electricity to be lost as heat every day—enough wasted energy to power 50,000 average U.S. homes for a year (Figure 2).

The lack of redundancy in the centralized model, together with its reliance on sprawling infrastructure, leave the electricity grid inherently vulnerable to damage and service interruptions. For example, the flooding, high winds and treefall caused by Superstorm Sandy in 2012 caused an estimated $65 billion in damages and wreaked havoc on electricity infrastructure across the East Coast. Eight million people were left without electricity and essential services (Reuters 2012). Nor is this problem unique to New York City; outages from weather events across the nation have risen from five per year before 1980 to more

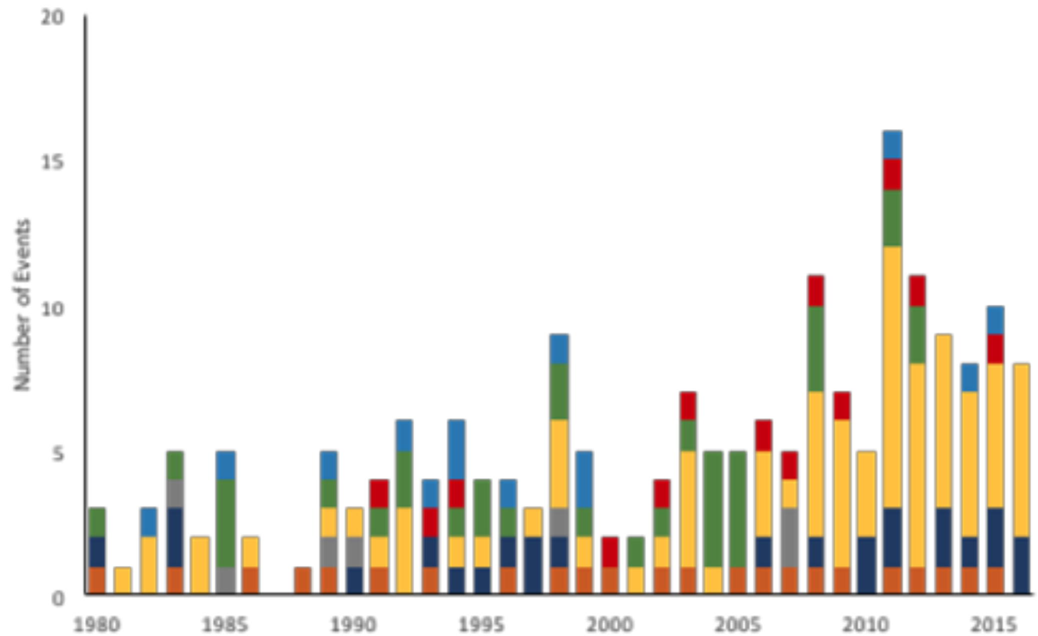

Figure 3 | Severe weather events causing in excess of $1 billion are becoming more frequent. Blue: winter storms; Red: wildfires; Green: tropical cyclones; Gold: severe storms; Navy: flooding; Orange, drought. Data are adapted from the National Oceanic and Atmospheric Administration.

than 100 per year (Amin 2011). Climatologists project that increasingly powerful severe weather events will occur at a higher frequency as atmospheric greenhouse gas concentrations and average global temperatures continue to rise (IPCC 2012). The economic impacts of these changes are being felt nationwide as the number of events causing more than $1 billion in damages also rises (Figure 3). Shifting electricity generation away from a centralized model is one path toward increasing resilience and reliability to address these threats.

The Clean Distributed Energy Grid Integration Act

United States Representatives Kathy Castor (D-FL) and Richard Hanna (R-NY) co-sponsored House Resolution 4393, the Clean Distributed Energy Grid Integration Act, as a response to the challenges posed by the inefficiencies and vulnerabilities of the current electricity grid. The Act promotes research and development into a diverse range of electricity generation technologies that can be located at the consumer site and on the consumer side of the electricity meter ("distributed generation"), reducing losses from transmission and distribution. In addition, the Act specifically focuses on clean technologies such as combined heat and power, fuel cells, and rooftop solar. Many of these technologies generate electricity more efficiently than traditional power plants and/or greatly reduce greenhouse gas emissions from the generation process. Currently, the energy sector accounts for more than 33 percent of U.S. greenhouse gas emissions—two thirds of which originate from coal combustion (EIA 2016b). Adopting and integrating clean energy sources on a national scale is therefore an essential step toward the U.S. commitment of reducing greenhouse gas emissions by 26-28 percent relative to 2005 levels by 2025, made in April 2016 as part of the Paris Climate Agreement.

Integrating distributed technologies into grid infrastructure allows excess energy produced at the consumer site to be fed back into the grid through a two-way electricity meter, creating a potential revenue stream for the consumer while increasing the stability of the overall grid and providing ancillary services to grid operators.

Since distributed sources feed electricity into the grid from many different locations simultaneously, the failure of a single source or piece of vital infrastructure does not result in failure of the entire network. The distributed model greatly reduces the likelihood of outages like the one experienced by Lower Manhattan during Superstorm Sandy, where the explosion of a single Con Edison distribution substation resulted in more than 250,000 residents being cut off from a source of electricity (Sugarman 2016). Diversifying energy sources therefore builds resiliency within the electricity grid.

Investments in improvements to the electricity grid pay dividends. Florida Power and Lighting invested more than $2 billion into its energy infrastructure to strengthen transmission and distribution lines while promoting distributed energy generation. Their investment was partially motivated by a ten-day blackout in Florida caused by Tropical Storm Sandy (Bloomberg 2016). In the aftermath of Hurricane Matthew in September 2016, Florida electricity providers were able to restore power to 90 percent of residents within two days (Bloomberg 2016).

While many of the technologies necessary to transition toward a distributed model of electricity generation already exist, there remain some technological, regulatory, and economic barriers to their full deployment and expansion. H.R. 4393 seeks to identify these barriers and address them through targeted research and development, as well as legislative recommendations. In the following document, we propose an implementation program that fully executes the mandates of H.R. 4393 and provides a pathway toward a clean, distributed electricity system in the U.S.

PROGRAM DESIGN

Legislative Mandates and Program Overview

The goal of the Clean Distributed Energy Grid Integration Act is to encourage the development of clean energy technologies on the consumer side of the electricity meter and hasten the large-scale integration of clean energy into the U.S. electricity grid. The implementation of this legislation would serve to improve grid resiliency, stability, and efficiency while reducing overall greenhouse gas emissions. The Clean Distributed Energy Grid Integration Act establishes five mandates to

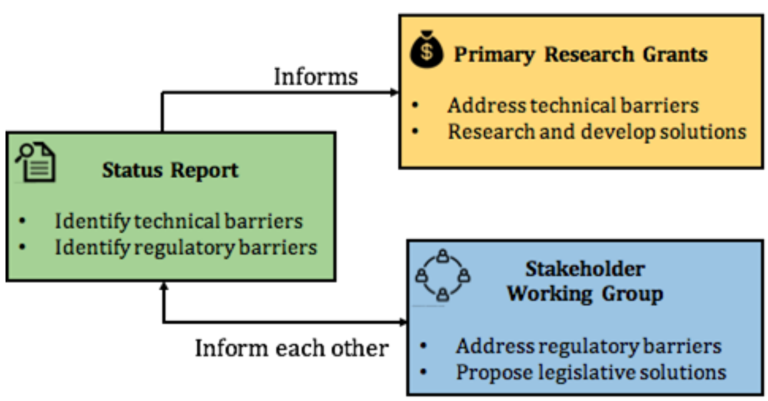

Figure 4 | Task Force program components active during the first 12 months. The three components of the Task Force for Clean Distributed Energy Grid Integration work cooperatively to identify and generate solutions to technological, regulatory, and economic barriers to the integration of distributed technologies into the electricity grid.

promote research into the barriers that hinder clean distributed energy integration and to develop solutions to those barriers. Each mandate must be completed within a set time frame beginning on the date that H.R. 4393 is enacted.

1. The Secretary of Energy will submit a Status Report to Congress within 12 months.
2. A Stakeholder Working Group that fully represents the electricity sector will be convened within 18 months.
3. The Secretary of Energy will solicit Primary Research Grants within 18 months.
4. The Secretary of Energy will issue grant funding to Demonstration Projects within 36 months.
5. The Secretary of Energy will submit an annual Progress Report to Congress.

In the following section, we propose a $6.8 million program that operationalizes these five mandates and embodies the spirit of H.R. 4393 for the first 12 months following the bill's enactment (Figure 4).

The program has been designed with a rapid roll-out that facilitates cooperation, partially internalizes quality control and output verification between program components, and satisfies the timeline requirements laid out in H.R. 4393. Guided and directed by a cross-cutting Task Force for Clean Distributed Energy Integration ("Task Force") created within the Office of Energy Efficiency and Renewable Energy, the program will identify and generate solutions to technological, regulatory, and economic barriers to the integration of distributed energy technologies into the electricity grid.

This program design brings together the strengths of research and development institutions with the industry knowledge of grid operators, regulatory organizations, and other organizations to ensure broad stakeholder participation and cooperation. In subsequent years, the Task Force's efforts will facilitate the initiation of legislative action and development of demonstration projects that actualize solutions to the regulatory and technological barriers identified in the first 12 months.

Table 1 | Potential stakeholders to be considered for membership in the Working Group. The 50-person Working Group will meet quarterly to identify regulatory barriers to clean distributed energy grid integration for the Status Report. Once the Status Report is completed, they will begin to draft legislative recommendations to overcome regulatory barriers that will ultimately be delivered to Congress.

Stakeholder Type	Potential Organizations
Regulatory Agencies	NERC, PUC, FERC
Renewable Energy Research Groups	NREL, MIT
Energy Economics Experts	ACEEE, USAEE
Environmental Organizations	Sierra Club, NRDC
Energy Legal Experts	Baker & McKenzie
Local Zoning and Regulatory Barrier Experts	New York REV, Los Angeles Department of City Planning
Utility Companies	Con Edison, American Electric Power Co.
Clean Distributed Energy Organizations	EDPR, Solarcity, SEIA

Component 1: Status Report on Clean Distributed Energy Grid Integration

Purpose: Conduct a gap and overlap analysis of the current state of distributed generation in the United States to address the first mandate of H.R. 4393.

Key output: A summary of key targets for legislative action and research and development funding, prioritized by feasibility, scalability and disruptive potential to be delivered to Congress.

The first deliverable of the Task Force will be an in-depth Status Report on Clean Distributed Energy Grid Integration ("Status Report"), the objectives of which are to provide a baseline survey of technical and regulatory challenges currently facing the energy sector and to identify areas where significant progress has already been made. The Status Report will utilize in-house research conducted by Task Force research analysts to generate a list of barriers constraining the scalability and integration of clean, distributed energy sources. A diverse stakeholder Working Group (detailed below) convened by the Task force will work simultaneously to generate a list of regulatory and economic barriers to contribute to the Status Report. The Working Group will review the barriers identified by Task Force research analysts, and vice versa, to take full advantage of available expertise and ensure that both lists are comprehensive.

In addition, the Task Force will select an external contractor through an open bid and evaluation process to conduct thorough impact analyses of all barriers identified. The contractors will then rank barriers according to their feasibility and potential for disruptive impact in the electricity system, creating a final hierarchy that will serve as a prioritized list to guide later program components as described below.

Contractors will be used because they provide specialized skills in multi-sector and economic impact analyses that cannot be matched by the in-house expertise at EERE or by the members of the Working Group. Additionally, outside contractors are potentially less subject to industry (or public) biases; as a result, they are ideal candidates to conduct the analyses necessary to rank and prioritize barriers to the widespread integration of clean distributed energy technologies into the U.S. electricity grid. Care must be taken to select appropriate contracting partners for this purpose, and Task Force Contractor Oversight specialists must develop an incentive structure that rewards timeliness and comprehensiveness to ensure that progress is made toward program goals—particularly given the interdependence of program components.

Component 2: Working Group for Clean Distributed Energy Grid Integration

Purpose: Utilize cross-sector expertise to ensure that all proposed solutions are implementable and scalable, and enable proactive industry responses to new technologies.

Key outputs: Barriers contributed to the Status Report and legislative recommendations to address regulatory barriers to clean distributed energy integration identified therein.

Beginning in the first quarter of January 2017, the Task Force stakeholder outreach specialists will convene a 50-member stakeholder Working Group for Legislative Action on Clean Distributed Grid Integration ("Working Group") composed of a wide range of energy sector representatives to leverage stakeholder knowledge for the Status

Report. Task Force analysts will select approximately 30 members from a pool of responses to a public request for applications with the aim of achieving broad energy sector representation and a diverse set of interests and expertise (see Table 1). The remaining 20 members will be appointed directly to the Working Group by the Program Team, which will seek to identify and fill any gaps in representation or experience not filled by qualified applicants. All selections and appointments made by the Task Force will be approved by the Program Director.

Once membership is finalized, the Working Group will meet once every 3 months for a period of 3 days in Washington, D.C. During this quarterly conference, group members will meet part-time in specialized subgroups and part-time as a full group to maximize cross-cutting collaboration and specialized expertise. Their responsibilities are twofold. During the first phase of the program, the Working Group will work in tandem with Task Force analysts to generate a comprehensive list of regulatory, economic, and technical barriers to clean distributed energy grid integration that will be analyzed and ranked by a specialized contractor to complete the Status Report. The Working Group will then enter a second phase, in which it will be responsible for drafting legislative solutions to the barriers identified in the Status Report. At each meeting, the Working Group will produce a written document proposing specific legislative recommendations to the Task Force at the conclusion of each conference. Proposed solutions will be evaluated by Task Force analysts and subject to a feasibility and impact analysis from the contractor, after which they will be delivered to the Secretary of Energy for referral to Congress.

Component 3: Primary Research Grants

Purpose: Create a theoretical framework to guide the development of demonstration projects and prototypes in 2018.

Key output: Theoretical solutions to the technological barriers to clean distributed energy integration identified in the Status Report.

Allocation: Maximum $5 million per fiscal year, distributed to grant applicants on the basis of merit.

While the Working Group drafts solutions to the regulatory and economic barriers identified in the Status Report, the Task Force will create a funding structure that awards merit-based grants to research institutions that apply to tackle the technological barriers identified in the Status Report. A public request for proposals that address these barriers will be published and proposals will be reviewed by Task Force analysts on an ongoing basis. Grant awards will prioritize projects that address higher-ranking barriers (i.e. proposed solutions with the greatest feasibility and projected impact), taking into account additional factors such as organizational expertise and cost-sharing. While the goal of the Status Report was to establish priorities for solutions-focused research, the Primary Research Grants are intended to develop a sound theoretical basis for proof-of-concept demonstration projects that will begin in the second year of our proposed program. To this end, Task Force analysts and contractors will conduct feasibility and impact analyses of the research generated through these grant awards in order to establish funding priorities for the final program component. All funding decisions will be finalized and approved by the Program Director.

Component 4: Grant-funded Demonstration Projects and Prototypes

Purpose: Accelerate the research and development of affordable, scalable technologies that facilitate clean distributed energy integration.

Key output: Proof-of-concept solutions to technological barriers to clean distributed energy integration identified in the Status Report.

Allocation: $15 million per fiscal year, maximum $5 million funding per project.

Finally, beginning in the first quarter of 2018, The Task Force will post a public request proposals from organizations that have the capability to act on the technical and regulatory solutions put forward by the grant recipients and the Working Group in the form of cost-sharing pilot projects ("Demonstration Projects"). As with the primary grants, funding for Demonstration Projects will be awarded to projects with the greatest potential for scalability and disruptive impact. The Task Force will monitor progress toward completion of these pilot projects and will assess their success or failure with the support of contractors and, where necessary, feedback from the Working Group. Successful technical solutions will work in harmony with the regulatory solutions proposed by the Working Group, laying the groundwork for industry-driven expansion and integration of distributed clean energy generation technologies into the electricity grid. All funding decisions will be finalized and approved by the Program Director.

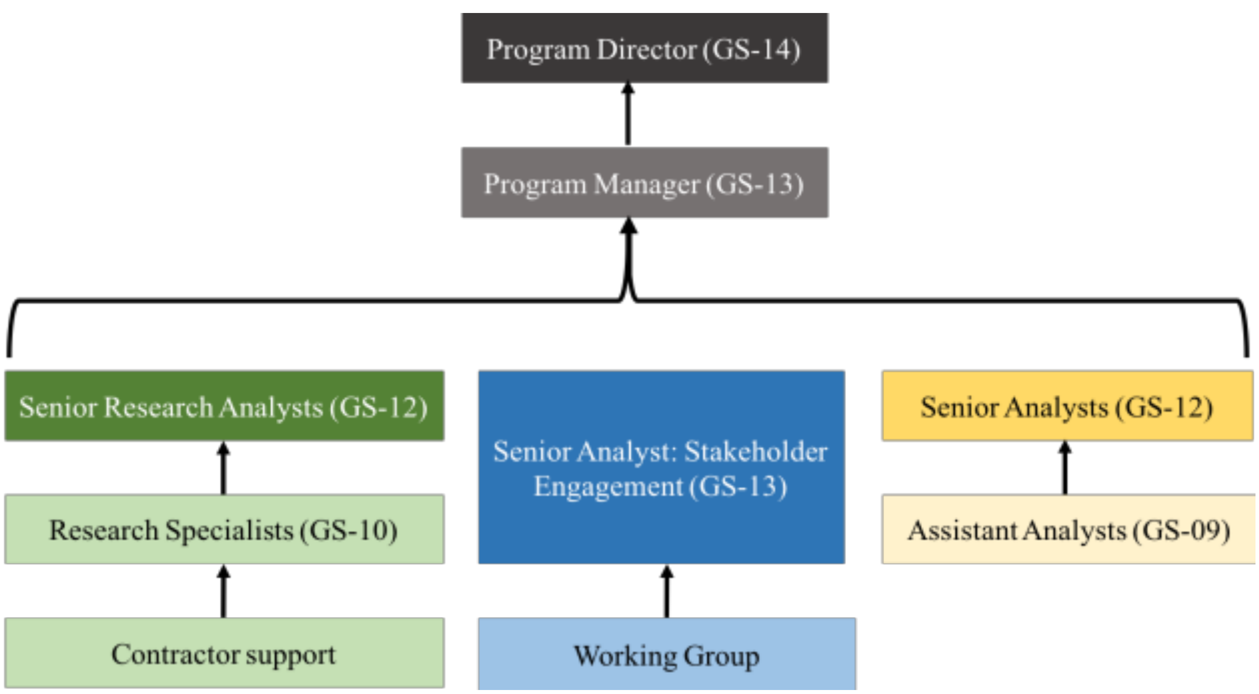

Figure 5| Organizational reporting structure. Though all program components are interrelated, each follows a distinct primary reporting structure. External contractors and the Working Group report directly to Task Force analysts, which synthesize and evaluate information before passing it up the chain to the Program Manager and Program Director. The Program Director ultimately reports to the Secretary of Energy.

ORGANIZATIONAL STRUCTURE

Within the Department of Energy, the Office of Energy Efficiency and Renewable Energy (EERE) encompasses programs related to efficiency, renewables, and grid modernization and works closely with the national laboratories to research and develop new technologies. We have selected EERE as the most appropriate branch of the Department of Energy to implement the mandates in H.R. 4393. It will a Clean Distributed Energy Grid Integration Task Force to implement the program laid out in this document.

The Task Force will operate as a program initiative under the umbrella of the EERE Office of Strategic Programs, with an internal reporting structure following Figure 5. With the exception of the creation of two program management positions, the Task Force will be formed from current employees already working on a range of energy- and grid-related projects. Thus, the Task Force will synthesize existing, disparate lines of work by focusing them on a common goal and will report quarterly to the Office of the Secretary of Energy.

STAFFING PLAN

Total staff: 11 positions
Total FTE: 10.25

The following staffing plan will allow for the successful management and implementation of the Act's first-year mandates, leveraging the available human resource experience in administering similar programs within EERE. This synergy is necessary in order to launch a cost-effective program.

Senior management staff

Program Director (GS-14, 0.25 FTE)

The Program Director is responsible for coordinating and supervising all aspects of the program, including staffing, organizing, leading, and controlling program activities in order to fulfill the mandates of H.R. 4393.

Program Manager (GS-13, 1.0 FTE)

The Program Manager is responsible for assisting the Program Director in overseeing the whole program design, as well as monitoring the budget and reporting on the progress of the program. The Program Manager will interact directly with the Task Force teams and fill an administrative function in approving operational activities and travel, Working Group appointees, contract awards, and other strategic decisions. Reporting and decision-making structures follow Figure 5.

Research staff

Research Analysts (GS-12, 2.0 FTE)
Research Specialists (GS-10, 2.0 FTE)

The Research Analyst and Specialist positions will be tasked with conducting in-house research on the technological barriers to the integration of clean, distributed energy into the electricity grid for incorporation into the Status Report. This process will involve reaching out to other offices within the Department of Energy and collaborating with the network of National Laboratories. In addition, the Research Analysts will work closely and continuously with the outside contractors hired to conduct impact analyses in order to ensure timeliness and verify output quality.

Stakeholder outreach staff

Stakeholder Engagement Specialists (GS-13, 2.0 FTE)

These positions staff will begin the process of identifying and selecting member organizations for the Working Group. They will serve as an interface and communication channel between the Working Group and the Task Force analysts responsible for the Status Report and Primary Research Grants. Two further specialists will be responsible for establishing, coordinating and convening the 50-member Working Group to address the regulatory barriers identified in the Status Report.

Grant review and evaluation staff

Senior Analyst (GS-12, 1.0 FTE)
Assistant Analysts (GS-09, 2.0 FTE)

These positions will be primarily responsible for developing grant award criteria based on impact analyses conducted by the Research Analysts and external contractors, and will work with both groups to evaluate the products of the Working Group and Primary Research Grant recipients.

Table 2 | Line item personnel costs. The Task Force for Clean Distributed Energy comprises a total of 10.25 full time equivalents (FTE), ranging from senior management staff to assistant analysts. Salaries are current annual estimates from the United States Office of Project Management; fringe costs are estimated at +30 percent of the base annual salary.

Position Title	Grade	FTE	Base Salary (annual)	Salary + Fringe
Program Director	GS-14	0.25	$21,750	$29,000.00
Program Manager	GS-13	1.00	$74,000	$96,000.00
Senior Research Analyst I	GS-12	1.00	$62,000	$82,000.00
Senior Research Analyst II	GS-12	1.00	$62,000	$82,000.00
Research Specialist I	GS-10	1.00	$48,000	$62,000.00
Research Specialist II	GS-10	1.00	$48,000	$62,000.00
Senior Analyst: Contractor Oversight	GS-12	1.00	$62,000	$82,000.00
Assistant Analyst: Contractor Oversight I	GS-09	1.00	$43,000	$56,000.00
Assistant Analyst: Contractor Oversight II	GS-09	1.00	$43,000	$56,000.00
Senior Analyst: Stakeholder Engagement I	GS-13	1.00	$74,000	$96,000.00
Senior Analyst: Stakeholder Engagement II	GS-13	1.00	$74,000	$96,000.00
Total	-	**10.25**	**$612,000**	**$800,000**

Table 3 | Line item non-personnel costs. Non-personnel costs include operational expenses for the Task Force and support for the quarterly conference for stakeholder Working Group members. Contractor fees are estimated at $1 million for the first year; all remaining funds are used to support Primary Research Grants.

Expense Category	Expense	Estimated Cost
Operational Costs	Printing and copy materials Travel for site visits and interviews	$2000 $28,000
Grants and Contracting	Primary Research Grants Contractor fees Equipment and technology	$4,400,000 $1,000,000 $2,800
Working Group Conference (held quarterly)	Member travel Member meals and incidentals Member lodging Event space and support Publicity and promotional materials	$200,000 $42,000 $126,000 $120,000 $13,000
Total	-	**$6,000,000**

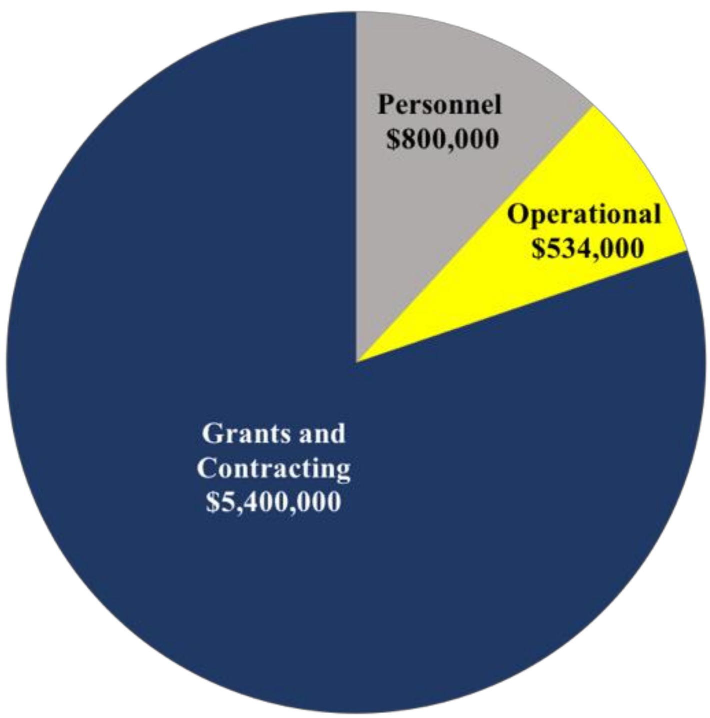

Figure 6 | Overall cost breakdown for the Task Force for Clean Distributed Energy Grid Integration. Costs for 2017 total $6.8 million, include personnel (12%), operational expenses and the stakeholder Working Group conference (8%), and grants and contracting support (80%).

BUDGET

Total cost: $6.8 million

Funding source: $5.8 million from DOE budget request, $1 million from DOE unobligated funds.

Total costs for the first year are estimated at $6.8 million, including Personnel Expenses ($0.8 million; 12%), Operational Expenses ($0.5 million; 8%), and Grants and Contractor Support ($5.4 million; 80%). Of these costs, $5.8 million will be drawn specifically from the Department of Energy budget, with the remainder from unallocated funds within the existing budget. Overall costs for the first year are allocated between Personnel Expenses, Operational Expenses, and Grants/Contractor Support as shown in Figure 6.

Total program costs will increase beginning in the first quarter of 2018 once all four program components are operating in parallel. However, as this document focuses on the first 12 months of implementation, we have not provided a detailed budget for the Demonstration Projects, the fourth and final program component.

Personnel costs

Total cost: $1.1 million per year.

Personnel costs are calculated based on a base wage set according to the General Schedule (GS) established by the U.S. Office of Personnel Management. The GS scale runs from grade 1 to 15, with substantial increases to annual salary at each grade. In general, grade levels are indicative of a positions seniority and responsibility level. We have assigned grade levels for Task Force positions commensurate to the level of experience and expertise required for each. For position descriptions and responsibilities, see the Staffing Plan above.

Table 4 | Mandates within H.R. 4393. The Clean Distributed Energy Grid Integration Act lays out the broad strokes for the program design in this document and sets timelines for the completion of each program component.

H.R. 4393	Mandate
Sec 4. (b) (1)	*Status Report must commence* ***not later than 180 days*** *after enactment*
Sec 4. (b) (3)	*Status report must be delivered to Congress* ***not later than 1 year*** *after enactment*
Sec 4. (d) (1)	*Stakeholder Working Group must convene* ***not later than 18 months*** *after enactment*
Sec 4. (d) (5)	*Stakeholder Working Group's report of recommendations delivered to Congress* ***not later than 3 years*** *after enactment*
Sec. 4 (c) (1)	*Issue solicitation for primary research grant proposals* ***not later than 18 months*** *after enactment*
Sec. 4 (c) (1)	*Issue solicitation for primary research grant proposals* ***not later than 18 months*** *after enactment*
Sec. 4 (e) (1)	*Issue solicitation for demonstration projects* ***not later than 3 years*** *after enactment*

Table 5 | Key Task Force milestones in 2017. The following table summarizes key milestones for each quarter of 2017 and responsible parties within the Task Force program.

Year 1	Milestone	Task Team
Q1	• Status Report staff assignment • Consultant Selection • 1st Status Report draft starts • Consultant report starts	Status Report
Q2	• 1st Status Report draft complete	Status Report
	• 1st Stakeholder Working Group meeting	Stakeholder Working Group
	• 1st Post-Stakeholder Working Group review • 2nd Status Report draft in progress	Status Report
Q3	• 2nd Status Report draft complete	Status Report
	• 2nd Stakeholder Working Group meeting	Stakeholder Working Group
	• 2nd Post-Stakeholder Working Group review • Final Status Report draft in progress • Consultant report complete	Status Report
Q4	• Final Status Report draft complete	Status Report
	• 3rd Stakeholder Working Group meeting • Stakeholder Working Group submits comments	Stakeholder Working Group
	• Final Status Report complete • Status Report submitted to Congress	Status Report

Each employee has associated fringe costs, such as worker's compensation and health care, that add to their position's cost. We have collectively estimated fringe costs to add an additional 30 percent to each position's annual salary. Table 2 gives a line-item summary of all personnel involved in the Task Force in the first 12 months of implementation.

Operational Costs

Total cost: $534,000 per year.

Operational expenses cover all of the day-to-day costs incurred by the Task Force in the fulfillment of their duties, including personnel equipment and travel for site visits and consultations. This category also includes expenses associated with the quarterly conference of Working Group participants in Washington, D.C. We have projected costs based on quotes and product research current as of December 2016. **Table 3** shows a line-item summary of projected operational costs throughout the first 12 months of program implementation.

Grants and contractor support

Total cost: $5.4 million per year.

All funding allocated by H.R. 4393 that is not required to cover personnel and operational costs will be used to fund Primary Research Grants and external contractor support for the analyst staff and working group. These costs represent the most substantial non-personnel cost of our proposed program. Contracting costs are projected to total $1 million over the first 12 months. The remainder of this funding—totaling $4.4 million—will be allocated to Primary Research Grant awards.

Table 3 summarizes line-item costs for grants and contractor support.

MASTER CALENDAR FOR YEAR ONE

This section details the master calendar for the first 12 months of implementation, with tasks, assigned personnel and milestones for expected deliverables (Figure 7). Given the Act's mandates on the timeline of implementation (Table 3**),** the master calendar rapidly rolls out the Status Report to be complete by the end of the first year, while setting up success for the stakeholder Working Group and Primary Research Grants and Demonstration Projects.

The program will be launched in first quarter of the first year with the establishment of the task force. Within the first year of implementation, three of the program's four components will be initiated: the Status Report, the Working Group and Primary Research Grants. The fourth mandate on solicitation of Demonstration Projects will begin only in the second year after the enactment of the bill. The first two years are depicted in Figure 7. Notably, only the Status Report group will conclude within the first year, while the three remaining components continue into the second year. The deliverables and processes of each of these mandates meet the timelines delineated by the provisions of the H.R. 4393 and are designed to interact with one another to identify, assess and address technological and regulatory issues (Figure 8).

Two staffing cycles will take place in the first year: Task Force Management, Status Report and Working Group teams will be initiated in the first quarter and the Primary Research Grants team will be initiated in the third quarter. Because this is an internal reassignment of staff already within the DOE, the ramping up of each team is expected to occur smoothly and quickly without need for a full recruitment and hiring process.

The relationships between teams responsible for each program component are crucial. The three teams have been scheduled with reference to one another such that they coincide, follow up with one another and form a critical path. The following critical factors exist in each quarter:

1. The Status Report team must deliver drafts to the stakeholder Working Group team at the start of quarters two, three, and four in 2017. These drafts will be discussed at three-day stakeholder Working Group meetings convened with the stakeholders, at the end of which the group will submit a response paper. Research Analysts will review their drafts using this response paper for two weeks before beginning the process for the next draft. The cyclical feedback process is represented in the flow of Figure 11.

2. The contractor report received by the Status Report team will also be submitted prior to the drafting of the final draft of the status report in quarter three and thus be included for review by the Stakeholder Working Group at their third meeting in quarter four.

3. The contractor report is simultaneously received by the Primary Research Grants team to develop their grant qualification criteria in quarter three, which will be presented together with the final draft of the status report and thus be included for review by the Stakeholder Working Group at their third meeting in quarter four.

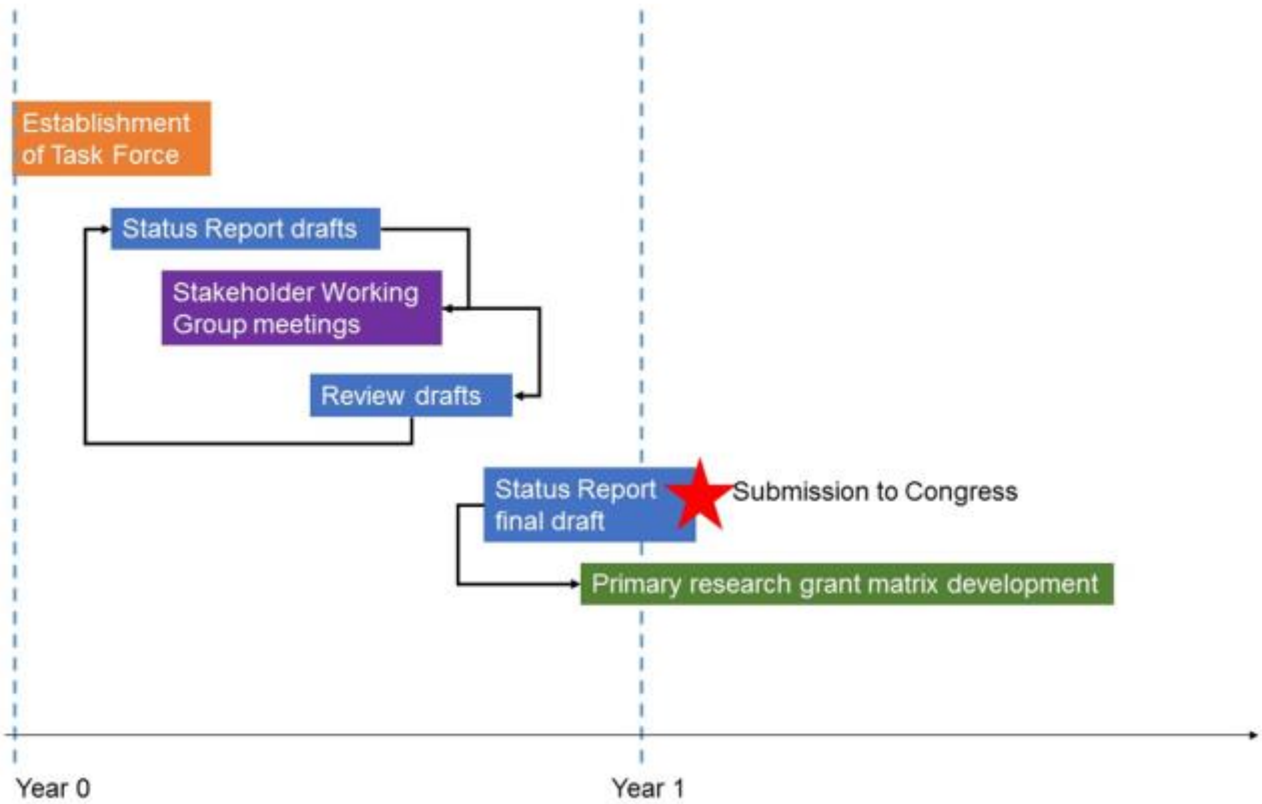

Figure 8 | Relationships and interactions between program components. The Status Report will be developed cooperatively by Task Force analysts and the Working Group. Once completed, the Status Report will be submitted to Congress and used to develop the criteria for Primary Research Grant awards.

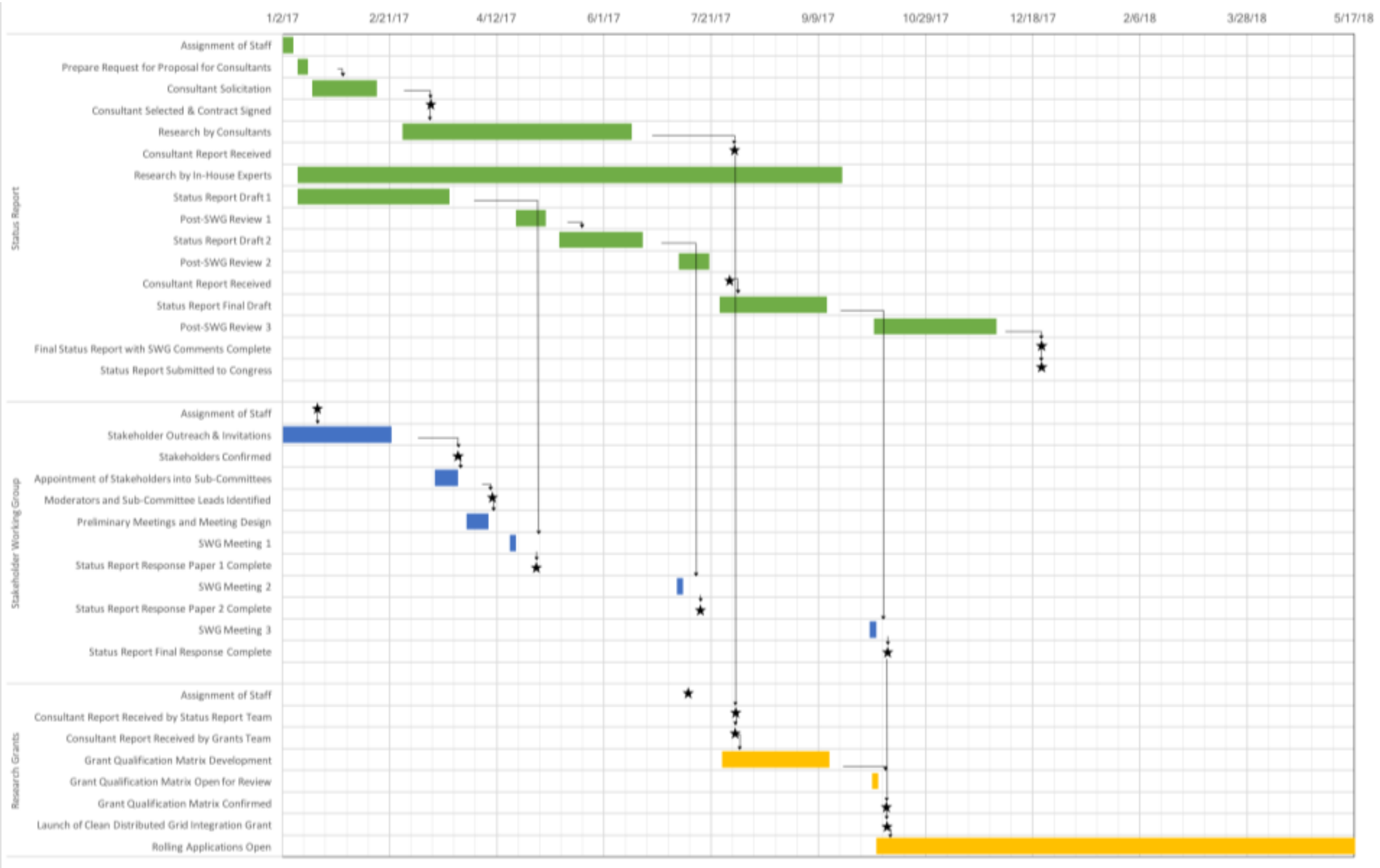

Figure 7 | Master calendar for the Task Force for Clean Distributed Energy Integration in 2017. Key steps are listed on the left along with responsible teams within the organizational structure. Stars represent milestones for each team; arrows connect precedents to the initiation of next steps**.** Colors correspond to program components as follows: Green, Status Report; Blue, stakeholder Working Group; Yellow, Primary Research Grants.

	Indicator Type	Measurement	Collection	Purpose
Component 1: Status Report	Operational	A completed Status Report, including a hierarchy of ranked barriers, delivered to Congress by December, 2017.	The Program Manager will collect this measurement.	To ensure the final requirement of this mandate is fulfilled on schedule.
	Regulatory	Ten regulatory and ten technical barriers identified in report.	The Status Report Team will collect this measurement on a quarterly basis, during the first year of implementation.	To determine how thoroughly the Status Report analyses current barriers to distributed energy integration.
		Working Group consensus on barrier rankings.	The Working Group will provide this measurement on a quarterly basis, starting April and finishing November 2017	To assure that the Status Report identifies the most critical barriers to distributed energy integration and includes all energy interests in that determination.
Component 2: Working Group	Operational	Attendance of Stakeholders at quarterly conferences.	The Stakeholder Engagement Specialists will track attendance on a quarterly basis, beginning in April 2017 and continuing throughout the life of the Working Group.	To indicate Stakeholder engagement and to assess whether or not Stakeholder diversity, outlined in the Program Design, is maintained.
		A report delivered to Congress by December, 2019	The Program Manager will collect this measurement.	To ensure the final requirement of this mandate is fulfilled on schedule.
	Regulatory	A minimum of four practical policy recommendations proposed per year.	The Stakeholder Engagement Specialists will collect this measurement on an annual basis, starting in 2018.	To assess the effectiveness of Working Group Conferences at developing legislative recommendations.
		Quality of policy recommendations.	The Research Specialists will conduct an impact review on all legislative recommendations on an annual basis, starting in 2018.	To determine the potential implementation and impact of legislative recommendations.
		Number of legislative actions taken based on Working Group recommendations.	The Stakeholder Engagement Specialists will collect this measurement on an annual basis, starting in 2018.	To validate the effectiveness of recommendations in encouraging legislative reform.

Figure 8 | Performance management table (continued on the following page). Operational indicators measure timeliness of project completion; regulatory indicators measure progress towards legislative solutions; technical indicators are quantitative measures of the impact of new technologies on the functioning of the grid itself, allowing for the direct comparison of clean, distributed and integrated systems with the current system.

	Indicator Type	Measurement	Collection	Purpose
Component 3: Primary Research Grants	Operational	Number of grant applications received.	The primary Grant Team will collect these measurements on an annual basis, starting in 2018.	To determine the success of the Primary Grant Team's outreach.
		Percentage of budget spent on grant awards.		To gauge how successfully the Primary Grant Team channels investment towards research.
		Funding provided by external investors.		To indicate how effectively the Primary Grant Team has leveraged DOE funding to encourage external research investment
	Technical	A minimum of four technical barriers addressed per year.	The Primary Grant Team will collect this measurement on an annual basis, beginning 2018.	To measure the success of the grant program at addressing the barriers provided in the Status Report.
		Quality of technical solutions.	The Research Specialists will conduct a research review on all funded projects on an annual basis, starting in 2018.	To determine the potential implementation and impact of research solutions.
Component 4: Demonstration Project Grants	Operational	Number of grant applications received.	The Grant Team will collect these measurements on an annual basis, beginning 2019.	To determine the success of the Grant Team's outreach.
		Percentage of budget spent on grant awards.		To gauge how successfully the Grant Team channels investment towards demonstration projects.
		Funding provided by external investors.		To indicate how effectively the Grant Team has leveraged DOE funding to encourage external research investment.
	Technical	MWh of energy incorporated into the grid.	The Project Grant Recipients will determine these measurements and report them to the Grant Team on an annual basis, beginning in 2019.	To determine the ability of the Demonstration Projects to contribute energy into the grid system.
		Number of customer hours of energy loss reduced.		The determine the ability of the Demonstration Projects to reduce grid outages.
		Greenhouse gas reduction		To determine the ability of the Demonstration Projects to reduce greenhouse gas emissions.

PERFORMANCE MANAGEMENT

The following section presents detailed key indicators of success for each program component. Operational indicators measure timeliness of project completion; regulatory indicators measure progress towards legislative solutions; technical indicators are quantitative measures of the impact of new technologies on the functioning of the grid itself, allowing for the direct comparison of clean, distributed and integrated systems with the status quo.

In addition, we identify metrics that will be used to evaluate program outcomes, which serve to ensure that the execution of our program design successfully and measurably promotes the integration of clean and distributed energies into the U.S. electricity grid through research and development—the overarching goal of H.R. 4393. **(Figure 8)** summarizes specific metrics for each component.

Program Outcomes

H.R. 4393 is intended to accelerate the integration of clean and distributed electricity generation on the consumer side of the electricity meter. Ultimately this transition will move the U.S. towards a more stable, resilient, and clean energy production system. To fulfill the objectives of H.R. 4393, our program design first identifies barrier to clean distributed energy, and then utilizes a diverse body of stakeholders to identify technological and regulatory solutions. If successful, the program will result in the following outputs and outcomes:

- An outline of the most critical implementation barriers, enabling the DOE and energy industry to strategically focus research investment and effectively speed up the transition from a centralized and vulnerable grid to a distributed and resilient one.

- Politically feasible legislative recommendations for eliminating the regulatory risks involved in investing in clean and distributed energy technologies and encouraging further development.

- Technical recommendations to lower costs and increase benefits to energy producers, distributors and consumers. Additionally these recommendations will improve the feasibility of these technologies and expand their use within the energy system.

- Tested technical solutions that have the potential to reduce grid outages and greenhouse gas emissions, while contributing additional energy to the grid.

CONCLUSIONS

With an aging, inefficient grid and carbon intensive method for producing electricity, the U.S. electricity system needs restructuring and reinforcement. As seen recently with Hurricane Matthew in the southern United States, investments in the electricity grid can measurably increase resiliency. Severe storms and weather systems will only become more frequent and intense in response to climate change. The current electricity generation and distribution system is also inefficient. The carbon intensity of conventional electricity-producing fuels like coal make electricity production one of the largest contributors to greenhouse gas emissions.

Shifting electricity generation away from carbon intensive, centralized generation to clean, distributed generation is a key solution for these issues. To increase the stability, efficiency, and resiliency of the current electricity grid, the Department of Energy must identify technical, economic, and regulatory barriers to clean, distributed energy and systematically develop cost-effective, scalable, and high-impact solutions to those barriers.

The implementation plan laid out in this document synthesizes the goals and mandates laid out in the Clean Distributed Energy Grid Integration Act into a comprehensive program that provides one path toward achieving these goals and meeting these goals. It focuses on targeted research and development into diverse technological and regulator solutions, incorporating public and private entities and fostering cooperation across the energy sector.

The program will therefore encourage the transition to a more stable, resilient, clean electricity production system in the United States.

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APPENDIX A: DEFINITIONS OF KEY TERMS

Ancillary Services	In an electricity market ancillary services are the transmission services that ensure power is delivered reliably, securely and efficiently through the interconnected system. The activities that support the delivery of seller to purchaser or consumer. Ancillary services include scheduling, dispatch, voltage stability, maintaining operating reserves, black starting, and load shedding.
Climate change	A change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. (IPCC)
Greenhouse gas	A gas that traps outgoing energy in the form of infrared radiation and causes the overall temperature of the earth to increase over time
Electricity Grid	A network of transmission lines, transformers, substation, and other infrastructure that deliver electricity from where it is produced to where it is consumed. The U.S. grid has three interconnections: Western Interconnection, Easter Interconnection, and Texas Interconnection.
Distribution System	The final step in the process of delivering electricity from production site to consumption site. Carries electricity from transmission system to consumers.
Stakeholders	Individuals and/or organization that have a specific interest in the integration of clean, distributed, energy and would likely want to be involved in discussions about the technical, economic, and regulatory barriers. These include ACEEE, the Sierra Club, Utility Companies, distributed generation technology developers, and others.
Working group	A collection of around 50 stakeholders defined above that will meet periodically to identify the barriers to clean, distributed, energy and proposed legislative solution to the identified barriers.
Primary research grants	A funding structure that awards merit-based grants to research institutions that apply to tackle the technological barriers to clean, distributed, energy. Grant awards will prioritize projects that address higher-ranking barriers (i.e. proposed solutions with the greatest

feasibility and projected impact), taking to account additional factors such as organizational expertise and cost-sharing. Intended to develop a sound theoretical basis for proof-of-concept demonstration projects that will begin in the second year of our proposed program.

Demonstration projects Projects that actualize solutions to the technological barriers identified in the status report. Funding for these projects will be awarded to projects with the greatest potential for scalability and disruptive impact. Successful technical solutions will work in harmony with the regulatory solutions proposed by the Working Group, laying the groundwork for industry-driven expansion and integration of distributed clean energy generation technologies into the electricity grid.

Blackout Complete loss of power and failure of the electric power grid overall an extended period of time for a large geographical area.

Distributed energy Electricity generation on the consumer side of the grid and usually smaller capacity that can be aggregated to provide power to meet consumer needs. The aim of distributed energy is to minimize electricity power loss that occurs during transmission.

Centralized Concentrated at one location and in the hands of one authority (utility). In most cases, centralized electricity is generated using fossil-fuels. The drawbacks of centralized energy are unreliability and instability under unforeseen events.

Smart grid Computerizing the electric utility grid to include two-way communication between the center station and grid. A device usually be installed to the grid for sending status information such as power meters, voltage sensors, error detectors.

Integration The linking or coordination of distributed generation systems to the main power grid. Incorporating the electricity grid to transmit energy produced from production plants to end consumers

Full Time Equivalent (FTE) A workload indicator that is used by management to determine the staffing needs of a project and the involvement of staff in a project. The calculation is based on the number of total hours worked divided by the maximum number of compensable hours in a full-time schedule as defined by law (Executive Office of the President of the United States of America.)

General Schedule (GS) Pay scale for federal employees in professional, technical, and administrative positions. In United States, General Schedule is ranging from 1 to 15. Level 8 to 12 typically refers to mid-level positions. Whereas level 13 to 15 are top-level supervisory positions.

Resiliency — The capability of electricity generation to adapt in quickly changing conditions. It includes the ability to recover from deliberate disruption and natural incidents.

Reliability — Producing stable and consistent results or ability to be relied upon. In the context of this program the ability of the grid to provide consistent and stable electricity to consumers.