Summary Testimony of
Dean Kamen
President of DEKA Research & Development Corp.
Before the House Subcommittee on Energy and Air Quality
Committee on Energy and Commerce
U.S. House of Representatives
May 3, 2007

I am very supportive of our need for a "smart" grid. However, we need a "smart" grid focused on our future needs rather than an improvement in the status quo. We are at the end of a historical model where residential and small business electrical needs are met solely by centralized generation. Micro Combined Heat and Power ("Micro CHP") is a developed technology where homeowners can heat their homes and generate electricity from a single basement system. This approach has numerous benefits: superior conversion of fuel energy to heat and electrical energy vs. centralized power plants, reduced pollution, ability to use multiple fuels and reduction in demands on the grid. In particular, it reduces the need for new grid capacity, eases congestion, provides necessary voltage support and provides a fundamentally higher level of reliability than even a "smart" grid could achieve.

To realize the benefits of micro CHP, a "smart grid" must allow for universal adoption and access for distributed generation and permit real-time, two way power and information flow. Other "smart" grid concepts, such as smart metering will find their value enhanced with the increased adoption of micro CHP. From a policy perspective, which is not my expertise, the government should remove barriers that impede rapid adoption, enact policies which accelerate desired behaviors and create a level playing field for current and potential industry participants.

Testimony of
Dean Kamen
President of DEKA Research & Development Corp.
Before the House Subcommittee on Energy and Air Quality
Committee on Energy and Commerce
U.S. House of Representatives
May 3, 2007

Chairman Boucher and Members of the Subcommittee. Good morning and thank you for your invitation to testify before you today. I am Dean Kamen, President of DEKA Research & Development Corp., a small research and development company located in Manchester, New Hampshire. I testify today as an inventor and engineer, rather than as an industry participant or expert – and profess no policy expertise. However, as an inventor/engineer, I have spent considerable time and effort developing one specific solution to help address certain energy challenges.

I am pleased that this Committee is addressing the requirements for the grid of the future. I believe that modernizing the grid is an essential element of improving our nation's energy future, and that the role of the grid will begin to change dramatically over the next 5 to 10 years. My fundamental advice is that before we embark on a massive investment to upgrade the grid, we should have a roadmap that leads to a grid capable of leveraging not only the innovations of today, but those of tomorrow.

Framing the Question

Regarding the grid, properly defining the end goal is a necessary first step before proposing any solution. Today, the essential role of the grid is to move electricity from its point of creation to its point of use - in a reliable, safe and economical fashion. While

much has changed over the past 100 years to improve the grid's reliability, safety and cost, one fundamental element has remained constant: electricity is generated centrally and distributed locally to homes and small businesses – basically a one way flow. However, in a world with ever greater constraints on the building of new generation and transmission infrastructure, but where energy demand continues to grow, it is my belief that the centralized generation, one-way flow paradigm is about to change. We are about to enter a world where a significant portion of our nation's energy production occurs at the residential or small business level, rather than solely at central power plants. Therefore, we must build a smart grid that both recognizes and enhances that inevitability. This paradigm shift is analogous to the way computing and telecommunications have changed over the last few decades - shifting from centralized to distributed structures. The good news is that much of the hardware and software necessary for a similar transition of our electricity infrastructure have already been developed and are readily available.

There are several technologies already being used, albeit on a very limited scale, for distributed generation. One I'd like to mention briefly is CHP, or combined heat and power, and more specifically micro-CHP which is the residential scale generation of both electricity and heat at the point of use.

Micro Combined Heat and Power (CHP)

The core benefit of CHP is that it is a significantly more efficient use of our scarce energy resources. Today's electricity generation and distribution systems are inherently inefficient, delivering only about one third of the energy of the primary fuels as useful

electric power. The other two thirds of the energy are lost as waste heat at the central plant or as "line losses" when the electricity travels from the point of generation to the end user. The irony is that we could use that heat in our homes for hot water or space heating – which accounts for over 60% of the energy used in a typical US home - but it is impractical to recover and transmit the heat from those central plants. Why not replace the furnaces or boilers in our homes with a much smaller version of that central plant? This can produce electricity locally and instead of throwing away the wasted heat, we can use it for our hot water or space heating. This is the fundamental idea of micro-CHP, which would shift the efficiency of fuel to energy delivered from around 33% to as much as 90% - a significant savings. Not only does this higher efficiency result in greater utilization of our limited resources, it also results in potentially significant reductions in CO_2 emissions and harmful gas emissions (NOx, SOx, and particulate matter) by burning less fuel for the same amount of energy delivered. The higher efficiency of micro-CHP has the added benefit that it results in economic savings to the homeowner by reducing their combined heating and electric bills.

CHP has been around for a while, but has typically been implemented only on large commercial or industrial scale. The good news is that now the technology has advanced to enable CHP in everyone's basement. In fact, micro-CHP units have already been installed in homes in Europe and Japan, which has over 50,000 units installed after being introduced several years ago. This same technology has just become available in the US.

In addition to its higher efficiency, micro-CHP has all the advantages of any other distributed generation source, including:

- Reduced demand for new power plants and transmission and distribution systems with their associated NIMBY (not in my back yard) issues

- Reduced grid congestion

- Ability to add capacity in increments of kilowatts rather than in gigawatt sized central plants

- Potential to use a diverse group of fuels – some of which can be renewable and/or locally produced, further enhancing energy security and efficiency

- Voltage support for the existing grid, helping prevent power disruptions across the broader grid

An ancillary, but critical benefit of CHP, and other forms of distributed generation, is that it provides local reliability that is virtually unobtainable by improving the current grid design. With the current grid, average US customers lose power for 214 minutes per year (99.96% uptime). This sounds quite reliable, but in fact, the US actually ranks near the bottom of developed nations in terms of reliability. In an increasingly digital world, where even small disturbances can result in losses of information and productivity, this results in an estimated cost to US consumers of $150B per year. Unfortunately, improving the reliability of the current system from 99.96% to 99.999% would require significant resources and would likely not address some of the major causes for outages, such as major storms. Incorporating CHP and other forms of distributed generation is a

more cost effective way of providing greater reliability at a local level, as well as bolstering the reliability of the broader grid.

It is important to stress that distributed generation and the current grid can and should coexist. The grid is very good at effectively distributing low cost baseload power to large, dense populations. In addition, the centralized generating plants used in the grid have useful lives of decades and will be producing power for many more years. Even if distributed generation grows to a significant portion of the generation in the US, the grid will still be an essential backup for these distributed systems, necessary for ensuring the highest system reliability.

The Grid of the Future and Role of the Government

Now imagine a world 20 years out – a new paradigm with generation both at the center and at the periphery: What must the grid look like? What "smart" features are required? Above all, the grid must continue to provide safe, reliable power. Beyond this, the grid should also be structured to allow the most efficient use of energy at any point and to take advantage of future opportunities for increased efficiencies. Specifically, the grid of the future should:

- Accommodate distributed generation sources easily
- Allow the realization of real-time two-way power and information flow
- Allow smart metering by which the true price of electricity can be measured

- Accommodate smart appliances which can be seamlessly integrated into a “smart metered” household

- Allow demand pricing and demand side management which will encourage more efficient energy use decisions

As I stated earlier, I am not a policy expert, however here are my thoughts regarding what the government can do to help this effort:

- Eliminate any regulatory barriers which impede rapid introduction and adoption of micro CHP and the required changes to the grid

- Implement policies which speed the adoption process, including creation of fair and equitable standards and incentives which drive individuals to appropriate behaviors sooner than they might without these policies

- Remain neutral as to which economic actors participate in these changes

* * *

In conclusion, I believe that with intelligent regulation and creation of a level playing field, there are tremendous opportunities for affordable, efficient, and environmentally friendly energy. Getting the “smart grid” right, while not the whole answer, is a critical piece of the overall energy solution. Thank you again for the opportunity to share my views with you today.