Your Smart Grid Environmental Benefits Toolkit

Can a Smart Grid deliver real environmental benefits in a time when they are sorely needed? Yes! According to recent studies, it can even reduce emissions at a lower cost than many of the newest clean energy technologies. In this article, we give you four tools to help inform your utility, ratepayers, regulators, or legislators that a Smart Grid offers huge environmental benefits:

- An outline of where these benefits are likely to come from
- An explanation of why these benefits are sometimes complicated
- An estimate of the magnitude of these benefits
- An argument that these benefits deserve more attention

The Context

In our September 2007 article on the environmental benefits of a Smart Grid, we identified areas where a Smart Grid could provide such benefits and highlighted some challenges in aligning stakeholders, overcoming transaction costs (costs associated with forming coalitions and negotiating with other parties), and organizing institutions to implement these projects. Now, we are going to give you the tools to make the case to your clients, constituents, investors, or ratepayers. This will help utilities make the business case for the infrastructure they need in place now to enable emissions reductions when climate legislation requires it.

Where Will the Emissions Reductions Come From?

The Smart Grid will reduce emissions in four ways:

(1) Enabling the integration of clean, renewable generation sources
(2) Reducing electrical losses
(3) Increasing penetration of distributed energy resources
(4) Increasing energy conservation through feedback to consumers

More specifically, emission reductions will come from:

- Expanded renewable resource integration, enabled by a Smart Grid through its “plug and play” capability.
- Reduced transmission and distribution electrical losses, as generation is placed closer to load, as load curves are flattened, as flow patterns are optimized, as more efficient components are deployed and as power quality (ex: harmonics and phase balance) is improved. Reduced losses translates to a corresponding reduction in gross generation, and hence, less emissions.
- Improved central generation efficiency, as units face flatter load curves.
- Increased penetration of Distributed Energy Resources, including Combined Heat and Power and Plug-in Hybrid Electric Vehicles. These resources could provide fine-tuned support for the grid and ancillary services to increase efficiency and reduce energy-consuming spinning reserves.
- Increased conservation, as software provides feedback information about emissions to the marketplace and to customers. This will also encourage consumers to invest in energy efficiency and demand response options to save money.
- Reductions in other major pollutants, such as NO_x, SO_x, particulate matter, ozone, and others due to conservation and the use of cleaner sources of power.

Why These Environmental Benefits are Sometimes Complicated

The focus of environmental laws in the future will be greenhouse gas emissions, and creative options will be needed to address this issue. Smart Grid technologies can challenge conventional thinking, particularly around emissions accounting. Utilities and regulators will need to recognize that, while a Smart Grid enables substantial opportunities for emissions reductions, the people who are paying, implementing, and benefiting may be different entities in different places at different times. The true accounting process begins when you consider the technology's role in the network, where advanced meters and other Smart Grid technologies can enable multiple methods of emissions reduction. The question then is, how much of this would you count if you were selling the resulting emissions reductions on a carbon market? How much of the reductions could you legitimately claim are due to the use of Smart Grid technologies?

Smart Grid technologies are often necessary, but not always sufficient, conditions for emissions reduction. For example, Plug-in Hybrid Electric Vehicles (PHEVs) need a Smart Grid for wide deployment, but they also need an advanced battery and an appropriate charging solution. A wide deployment of the PHEV can help environmentally both by reducing tailpipe emissions and by improving the operating efficiency of the grid through ancillary services. While a Smart Grid can reduce the costs of these deployments, there are also ways to design emissions reduction projects without a Smart Grid. Hence, the additional benefit of using a Smart Grid may be hard to measure.

An Estimate of the Magnitude of These Benefits

While there exists no comprehensive quantitative study that catalogs all the Smart Grid's environmental benefits, some more limited studies provide an indication of just how large these benefits can be.

For example, an Electric Power Research Institute (EPRI) study done in 2003 looked at some environmental benefits that might accrue from the deployment of a nationwide Smart Grid. EPRI found that a full deployment of a Smart Grid and the energy efficiency improvements and new technologies that it enables can reduce greenhouse gas emissions by between 13% - 25% [1]. This equates to a greenhouse gas reduction potential of 100 – 200 Million Metric Tons of Carbon Dioxide equivalent (MMT CO_2e)[a]. This is roughly equal to taking 1-2 million cars off the road every year.[4]

Other groups that have assessed demand response or advanced meters show that most of the cost of those deployments is already returned in operational benefits; environmental benefits are frosting on the cake[b]. A meta-study of over 200 demand response pilot programs similarly found that on average, demand response programs reduced total energy consumption by 4%.[2] Whether a drop in overall energy consumption would result in a net reduction in emissions depends on more complicated issues such as generation mix, dispatch order, consumer investments in conservation and other considerations,

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[a] The EPRI paper suggests that this reduction could be achieved at a cost-effectiveness of between $42 / Metric ton carbon dioxide equivalent (MT CO_2e) and $83 / MT CO_2e [3]. This value is only based on greenhouse gas reduction cost-effectiveness, and completely ignores any other benefits from improved power quality, security, reliability, and direct economic returns, which in total EPRI estimates at benefit to cost ratio of 4:1[3]

[b] A white-paper from The Brattle Group in 2007 highlights the potential of advanced metering in combination with demand response to reduce peak load. The paper suggests that most of the cost of the meters is recovered in operational benefits[5].

and would vary by region. However, if the right designs are used, demand response programs can result in large emissions reductions in addition to other benefits.

Worldwide, Smart Grid technologies can prevent about 2,000 MMT CO_2e of emissions, or about 4% of worldwide emissions in 2020, according to a recent study by The Climate Group[6]. This, together with other Information and Communication Technologies (ICT) opportunities (in the key areas of travel/transport, buildings, and industry systems), suggests a potential reduction of about 15% of total worldwide emissions in 2020 [6]. This is especially important to recognize in developing countries where grid reliability and efficiency is poor, resulting in excessive emissions. The Climate Group's study echoes the findings of a report by the Commission of the European Communities to the European Parliament, which states that "ICTs have an important role to play in reducing the energy intensity and increasing the energy efficiency of the economy, in other words, in reducing emissions and contributing to sustainable growth." Europe clearly understands the role that Smart Grid and other ICTs must play in a carbon-constrained world.

Even without considering the other benefits, these studies suggest that the cost-effectiveness of greenhouse gas reduction via the Smart Grid is superior to greenhouse reduction from coal-based carbon sequestration, biomass and bio-fuels, and other technologies that gather significantly more media attention[7]. Exelon CEO John Rowe recently said in a speech that every \$10/Mt CO_2e rise in the cost of carbon due to a carbon tax or a carbon cap will raise the price of electricity by about \$0.01/kWh[8]. He believes that this will cause electricity rates to rise by \$0.10/kWh in the near future[8]. Having more options to reduce greenhouse gases at a lower cost, including those enabled by a Smart Grid, will slow the upward march of electricity prices. In other words, a Smart Grid can save ratepayers money by reducing emissions more cost effectively than other more popular options.

These Results Deserve More Attention

The bottom line is that taking these environmental benefits into account can help you pay for a Smart Grid. A more rigorous accounting of potential emissions reductions from Smart Grid technologies will give utilities a better case to bring to their regulators, ratepayers, investors, and the public. These benefits are also cheaper than many other methods of reducing greenhouse gas emissions.

The existing studies, while impressive, only begin to address the topic. Given the huge potential of Smart Grid-enabled environmental benefits, an effort to fully capture and quantify this opportunity is now absolutely essential.

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For more information about emissions related to electricity generation, please also see these sources:

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