# Potential Energy and Carbon Benefits of a Smart Grid

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# Scope and Methodology of the Study

- *Question*: Does the smart grid have a substantial role to play in the nation's carbon management agenda?
- *Goal*: Estimate the range of potential energy and carbon benefits attributable to the smart grid
- Two classes of benefits reducing in energy consumption and emissions resulting …
  - *directly* from smart grid applications
  - *indirectly* from reinvestment of cost savings
- Nine mechanisms for reducing energy and carbon were investigated

# Preliminary Results from Study by PNNL

| Mechanism | Electricity Sector Energy and Carbon Reductions* | |
|---|---|---|
| | Direct | Indirect |
| Conservation Effect of Demand Response Consumer Information | 3% | - |
| Marketing/Outreach Synergy Between Demand Response and Efficiency Programs | - | 0% |
| Measurement and Verification for Efficiency Programs | 1% | < 0.2% |
| Smart Grid-Enabled Diagnostics in Residential and Small/Medium Commercial Buildings | 3% | - |
| Conservation Voltage Reduction and Advanced Volt/VAr Control | 2% | - |
| Load Shifting from Demand Response | < 0.1% | - |
| Support Additional Electric Vehicles (EVs) / Plug-In Hybrid Electric Vehicles (PHEVs) | 3% | - |
| Reduced Need for Regulation and Reserves to Achieve 25% RPS: Solar Photovoltaic Integration and/or Wind Energy Integration: | < 0.1% | 5% |
| **Total Savings** | **12%** | **5%** |

EPRI's *Green Grid Report* estimates direct reductions in range of 2% to 7% at less than 100% smart grid penetration

* Assumes 100% penetration of smart grid in 2030; lower penetration produces proportionately smaller impacts

- Considerable uncertainty exists for each mechanism investigated: typically ~ ±50%
- Note EPRI investigated somewhat different mechanisms on a different basis



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# A Smart Grid Will Make a Significant Contribution

- Full implementation of smart grid functionality will provide substantial reductions in U.S. energy consumption and carbon emissions:
  - 9% direct reductions
  - 3% additional direct reductions by supporting additional EVs & PHEVs* at very high penetrations (> 60%) by smart charging
  - 5% indirect reductions from reinvestment of $ from avoiding the addition of extra capacity for regulation and reserves to support a 25% renewable portfolio standard
- The smart grid may be essential to achieving levels of renewables >> 25%, particularly for solar PV

* electric vehicles and plug-in hybrid electric vehicles

# Extra Slides

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# Basis for Direct Energy/Carbon Reduction Estimates

| Direct Reduction Mechanism | | Reduced Energy Consumption (2030) | | | |
|---|---|---|---|---|---|
| | | Est. | Low | High | Baseline Energy Consumption<br>End Use Sectors |
| A. | Conservation Effect of Demand Response Consumer Information | 6% | 1% | 10% | Residential |
| | | 6% | 1% | 10% | Sm./Med. Commercial |
| C. | Measurement and Verification for Efficiency Programs: Marginal Efficiency Measures Enabled by Acurate M&V | 7% | 5% | 20% | Residential (Heat Pump & AC) |
| | | 7% | 5% | 20% | Sm./Med. Commercial (HVAC + Lighting) |
| D. | Smart Grid-Enabled Diagnostics in Residential and Small/Medium Commercial Buildings | 15% | 10% | 20% | Residential (Heat Pump & AC) |
| | | 20% | 10% | 30% | Sm./Med. Commercial (HVAC + Lighting) |
| E. | Conservation Voltage Reduction and Advanced Volt/VAr Control | 2% | 1% | 4% | Total Electric Supply |
| F. | Load Shifting from Demand Response | 0.04% | 0.02% | 0.06% | Total Electric Supply |
| G. | Support Additional Electric Vehicles (EVs) / Plug-In Hybrid Electric Vehicles (PHEVs) | 3% | 2% | 5% | Light Vehicle Transportation (cars, vans, SUVs, light trucks) |
| H. | Solar Photovoltaic Integration (20% RPS): Reduced Energy for Regulation | (Note: Estimates for extra regulation required for meeting a 25% RPS with solar PV integration are not available, but may be similar to that for wind. If so, and PV is used instead of wind, or to supplement it, in meeting a 25% RPS requirement, the savings are already included in the estimates for wind integtration.) | | | |
| I. | Wind Energy Integration (20% RPS): Reduced Energy for Regulation | 20% | 10% | 30% | 0.1% Additional Regulation |

# Basis for Indirect Energy/Carbon Reduction Estimates

| | Indirect Reduction Mechanism (Reinvestment of Capital Savings in Efficiency/Renewables) | Avoided Captial Expenditure Reinvested to Save Carbon (2030) | | | |
|---|---|---|---|---|---|
| | | Est. | Low | High | Baseline Captial Expenditure / Investment |
| B. | Marketing/Outreach Synergy Between Demand Response and Efficiency Programs | 0% | 0% | - | 10% Demand Response, Residential @ $400/kW & 8.8¢/kWh |
| | | 0% | 0% | - | 10% Demand Response, Sm./Med. Commercial @ $300/kW & 8.8¢/kWh |
| C. | Measurement and Verification for Efficiency Programs: Joint Marketing of Efficiency & Demand Response Programs | 1% | 0% | 2% | 10% Energy Efficiency, Residential @ 8.8¢/kWh,10-Yr Life |
| | | 1% | 0% | 2% | 10% Energy Efficiency, Sm./Med. Commercial @ 8.8¢/kWh,10-Yr Life |
| H. | Solar Photovoltaic Integration (25% RPS): Reduced Capital for Reserve Capacity | (Note: Estimates for extra reserve capacity for meeting a 25% RPS with solar PV integration are not available, but may be similar to that for wind. If so, and PV is used instead of wind, or to supplement it, in meeting a 25% RPS requirement, the savings are already included in the estimates for wind integtration.) | | | |
| I. | Wind Energy Integration (20% RPS): Reduced Capital for Reserve Capacity | 2% | 1% | 3% | 1,111 GW Total Capacity @ $1000/kW |