Section F:

Engineering and Economic Factors Affecting the Installation of Control Technologies

Engineering and Economic Analysis Introduction

- **Estimates were made for the resources required for the construction and operation of control technologies for the Clear Skies Act based on the projected number of retrofits from IPM modeling analyses. The demand for resources due to the Clear Skies Act was compared to the current supply in today's market.**

- **It is expected that there will be a market response, however not instantaneous, to the demand for engineering, labor, construction equipment and materials for the installation and operation of a significant number of control technologies.**

  – It is projected that there are sufficient resources to meet the phase I caps in 2010 although some resources may be put under more pressure than others. Boilermaker labor is one of the resources that may be under pressure in the early part of phase I due to the simultaneous installation of NOx controls for the NOx SIP call.
  – It is difficult to predict the market supply of resources beyond phase 1, however, if the current availability of resources is sustained, it is expected that the supply will meet the demand beyond 2010. Sufficient planning time for the 2018 phase II caps should allow ample time for the market to meet the resource demands.

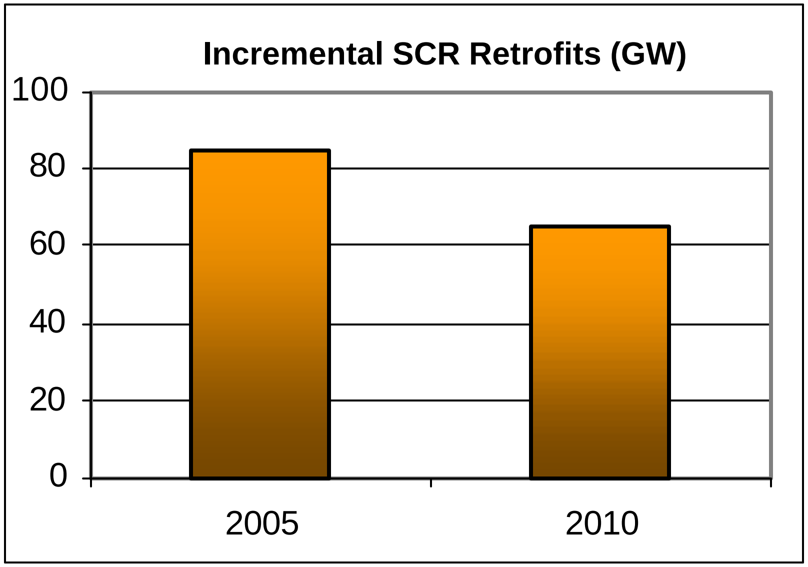
- **Alternative approaches to meeting the emission targets are likely to produce technologies and means of meeting the caps with less resources than what was projected.**

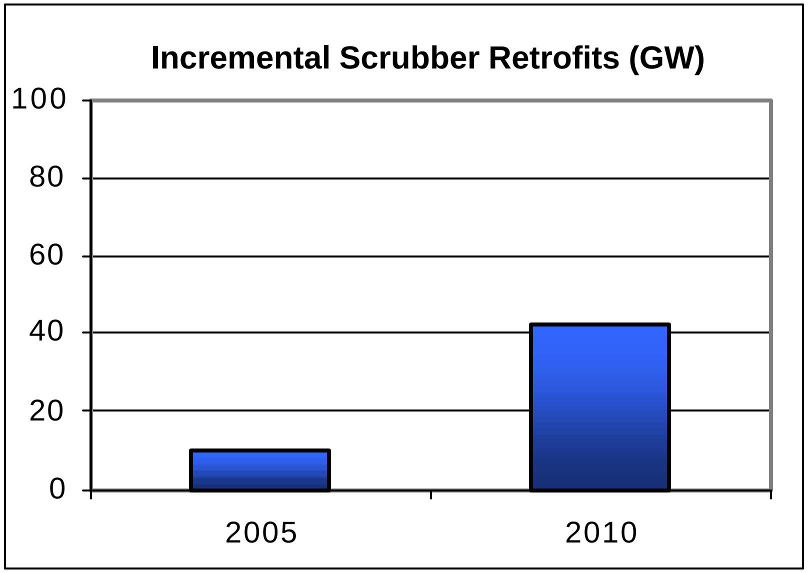
  – Scrubber technology improvements and switching to lower sulfur coal under the Acid Rain Program are examples of how alternative approaches required less resources than projected.
  – The development of control technology alternatives to SCR under the NOx SIP call is another example of innovations which may reduce the resource requirement of a given program.
  – Multi-pollutant control technologies are being developed which may provide integrated treatment of multiple pollutants as opposed to the standard approach of add-on technologies for each pollutant.

- **Resource requirements for coal-fired installations of selective catalytic reduction (SCR) for NOx control and flue gas desulfurization (FGD) for SO2 control were considered. Conservatively high assumptions for the resource requirements for these single pollutant control technologies were used.**

Capacity Projected to Install Control Technologies

- **The incremental number of SCR and FGD control technology retrofits, beyond what was in place by 2000, projected under the Clear Skies Act for 2005 and 2010 are provided below.**
  - The 2005 projected SCR retrofits include about 72 GW of SCR needed to meet the NOx SIP call with an additional 13 GW for state multi-pollutant rules. None of the SCR retrofits for 2005 are in response to the Clear Skies Act. It was projected that 6 GW of FGD, more commonly called scrubbers, would be installed by 2005 and a total of 9 GW by 2010 due to existing regulatory programs.
  - IPM modeling projected that 32 GW of scrubbers would be cost effective to install by 2005 during the simultaneous installation of SCR for the NOx SIP call. However, a scrubber sensitivity analysis projected that up to 10 GW of scrubbers could be installed before 2005 as resources such as boilermaker labor may be limiting.



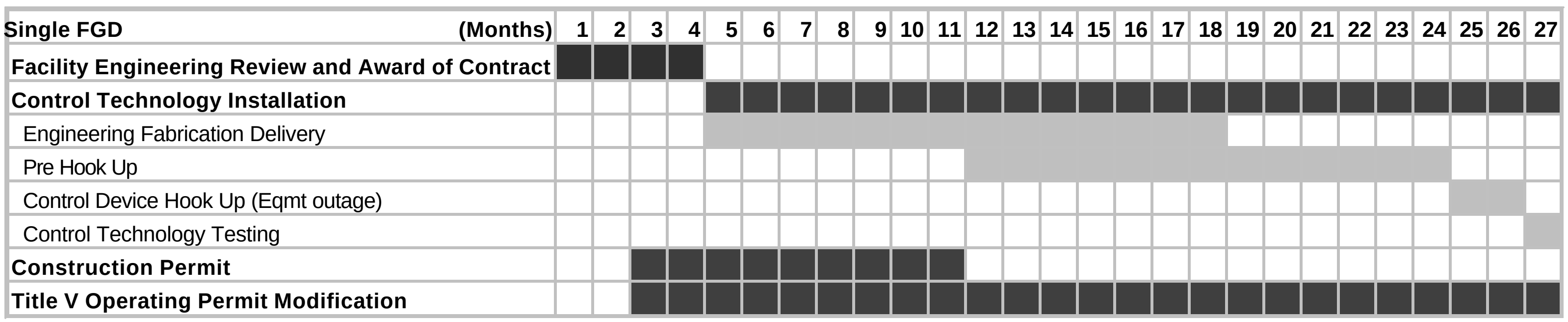


- **Through 2010, 0.4 GW of activated carbon injection (ACI) controls for mercury are projected to be installed and therefore are expected to have a negligible affect on the availability of resources in phase I of the program.**

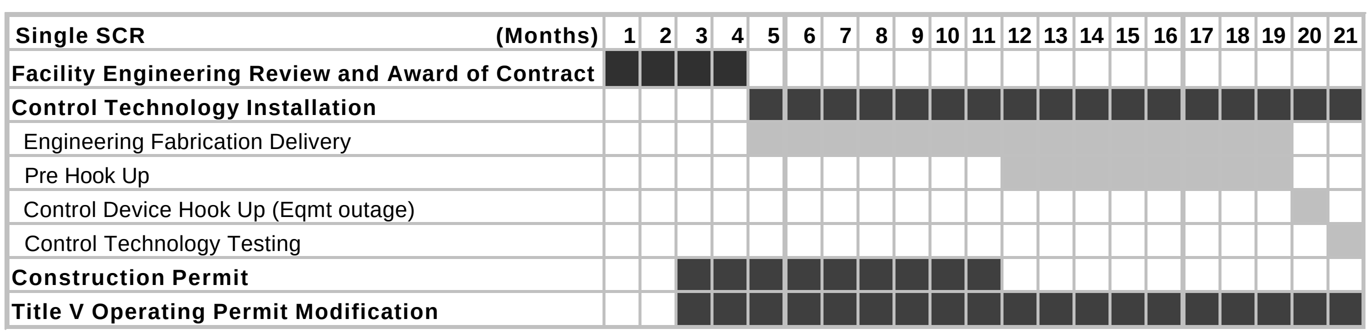
Control Technology Installation Times

- **Based on engineering analyses, EPA estimated the time it takes for a typical 500 MW unit to install control technology, including the time required for engineering review, construction permitting, control installation, and obtaining an operating permit:**

- **27 months for typical wet limestone scrubber installation**
  - Examples of installation times: 27 months for 890 MW retrofit of two units at Big Bend Station, 24 months for each 730 MW unit at Centralia from contract award to commissioning



- **21 months for typical SCR installation**
  - Examples of installation times: 13 months for 675 MW Somerset Station, 19 months for two 900 MW units at Keystone



Note: May find examples of longer installation times, depending on the regulatory driver

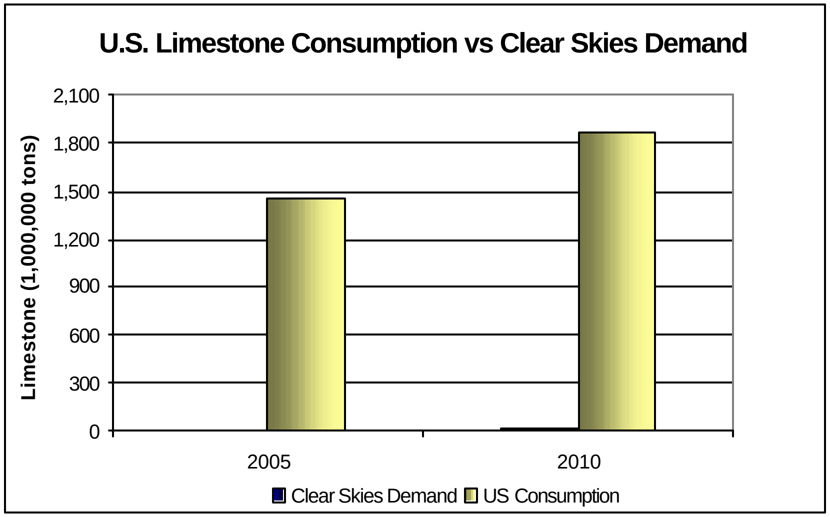
Control Technology Installation Times

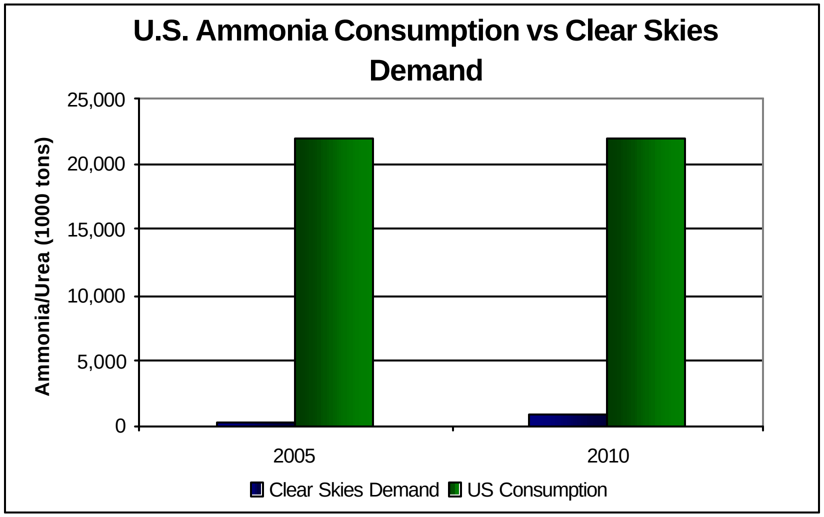
- Control device hookup to the boiler is typically scheduled during unit shutdowns which occur outside of the peak load summer months.
  - Typically takes 4-7 weeks for FGD hookup
  - Typically takes 3-5 weeks for SCR hookup
  - Other activities may be scheduled during shutdown which may prolong outage

- Control installation times for multiple retrofits of the same technology (e.g. 2 SCRs) at the same plant typically add 2 to 3 months to the single unit installation time for each unit, since much of the work involved in multiple retrofits can be done simultaneously.
  - Six units were the maximum number of units at one plant projected to be retrofitted with SCR by 2010. It may take from 33-37 months to complete the installation considering no hookup during the peak summer months.
  - Five units were the maximum number of units at one plant projected to be retrofit with FGD by 2010. It may take up to 36-40 months to complete the installation considering no hookup during the peak summer months.

- Scrubbers and SCRs may be simultaneously installed on the same unit as their locations do not usually cause much construction interference. In addition, simultaneous installations more efficiently use labor, construction equipment, and outages for hookup to the boiler.

Resources for Operation of Control Technologies





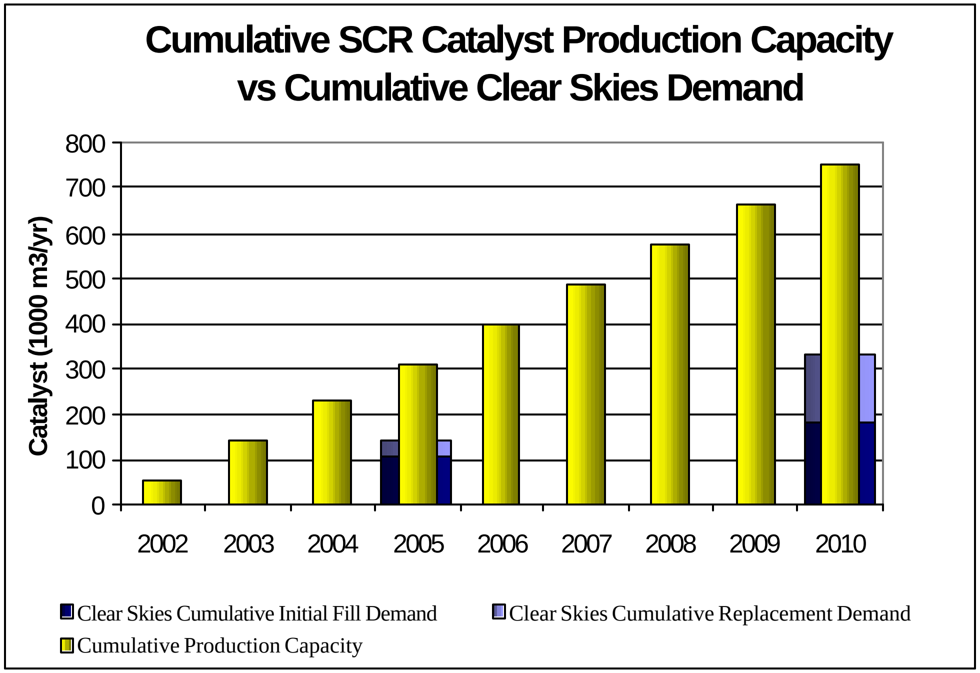
- The amount of reagent required to operate air pollution control technologies (e.g. limestone for scrubbers and ammonia for SCR) is very small relative to the US and world supply of these commodities.

- Limestone consumption in scrubbers for SO_2 reduction is projected to require less than 2% of the total U.S. consumption out to 2010. This estimate was conservatively high as it assumed only wet limestone scrubbers will be installed on units burning 4% sulfur coal, achieving a 95% SO2 removal efficiency, and having a capacity factor of 85%. The US consumption includes a 5.1% annual growth of limestone production based on recent market trends reported in the Minerals Yearbook by U.S. Geological Survey.

- Ammonia consumption in SCR for NOx reduction is projected to consume approximately 3% of the total U.S. consumption out to 2010. Recently, there was significant production capacity built in the US, Algeria and the former Soviet Union, along with 1.2 million tons of capacity built in Trinidad and Venezuela which could accommodate this increase in demand.

SCR Catalyst Availability

- SCR catalyst is one of the material resources which is unique to the air pollution control technology industry. Estimates of demand for SCR catalyst were based on both initial installed capacity and the annual replacement capacity requirements for the projected retrofits and also includes the replacement demand from all current world SCR installations.



Note: Additional catalyst supply from regeneration processes and production capacity for gas/oil fired SCR applications were not considered in this estimate.

- Current worldwide SCR catalyst production capacity for coal-fired SCR applications reported by the major manufacturers is estimated at almost 90,000 m^3/yr.

- Catalyst demand is expected to increase significantly as it is estimated that about 150 GW of SCR will be installed in the US by 2010, with 85 GW due to the NOx SIP call and state rules by 2005.

- The sum of the production capacity for each year starting in 2002 was compared to the cumulative Clear Skies demand from each 5 year increment. The percent of current cumulative production needed for Clear Skies is 45 % in 2005 decreasing to 44 % in 2010.

- Early in phase I, the majority of the catalyst demand is due to the initial fill of the catalyst reactor at new installations but the demand begins to shift over time to replacement demand.

Resources for Construction of Control Technologies

Steel, Hardware and Construction Equipment Requirements:

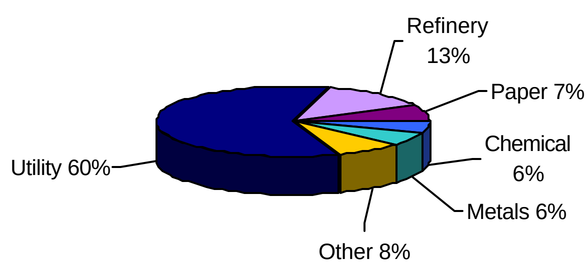
- Estimates of the cumulative steel demand needed to construct the control technologies (e.g. scrubber and SCR) yields less than 0.1% demand of the total US consumption per year reported in the Census Bureau's Current Industrial Reports.
- Steel is primarily needed for ductwork, support steel, storage silos, and reactor vessels for the control technologies. Some corrosive resistant steel alloys, rubber-lined steel or other materials may be used in the corrosive regions of scrubbers.
- Other hardware items such as piping, nozzles, pumps, fans, soot blowers and related equipment required for typical control technology installations are used in large industries such as construction, chemical production, and auto production and should be readily available.
- The availability of cranes, used to lift heavy pieces of equipment, are not expected to be a problem due to the extended time provided for planning installations. In addition to the cranes currently available, it is estimated that 12 new cranes can be supplied every six months if needed.

General Construction Labor Requirements:

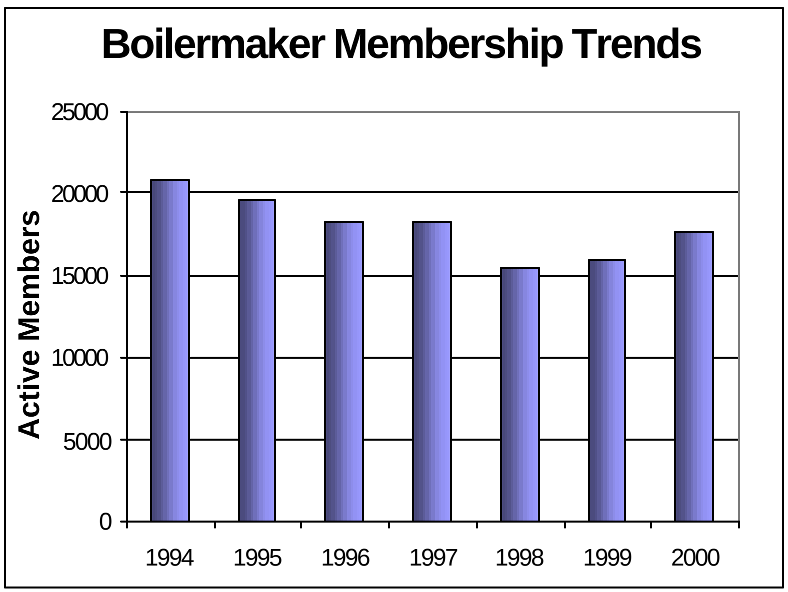
- Labor requirements are generally split between two categories, one for general construction labor and another for skilled labor (e.g. boilermakers, pipe fitters, electricians).
- General construction labor requirements for control technology installations are expected to be less than 0.3% of the current national labor pool of 6.7 million workers as reported by the Bureau of Labor Statistics.

Labor for Construction of Control Technologies

Boilermaker Demand by Industry

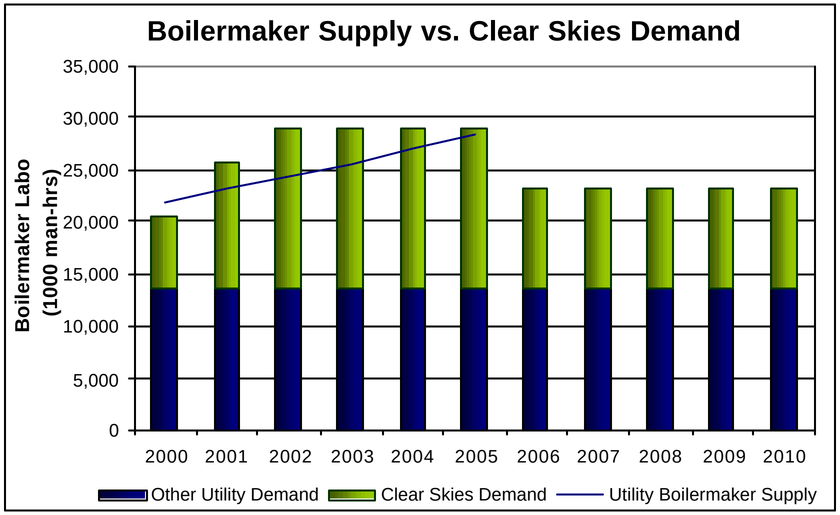


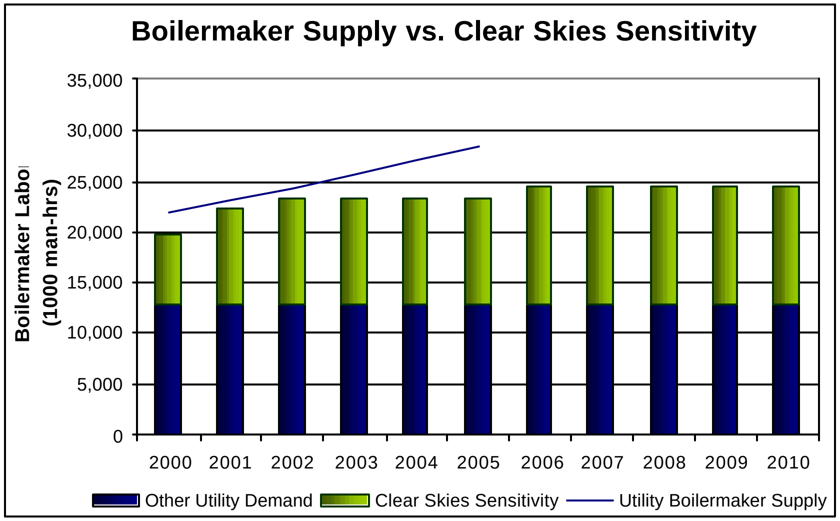
- Boilermakers are a skilled labor force used in the construction of high-energy vessels. Boilermaker apprenticeship takes up to 4 years but may require less time depending on the prior work experience and skill level of the individual.
- In 2000, 60% of the boilermaker journeymen were working in the electric utility sector. The remainder of the boilermakers were used in the refinery, chemical, metals, or other industries.



- Boilermaker numbers decreased from over 20,000 members in 1994 to just over 15,000 members in 1998.
- Boilermaker membership grew 6.7% from 1998-2000 and is projected to grow at a rate of at least 5.3% out to 2005 according to the International Brotherhood of Boilermakers.
- Their numbers have begun to rebound in recent years due to the construction of NOx controls for the NOx SIP call and new combustion turbine projects.

Labor for Construction of Control Technologies





Note: The boilermaker labor considered to be available for the Clear Skies control technology installations were from the portion of boilermakers employed in the electric utility industry.

- Boilermaker labor requirements based on control technology vendor experience were assumed to be approximately 40% and 50% of the total FGD and SCR labor requirement respectively.

- Economic modeling projects that 32 GW of FGD is cost effective to build by 2005. However, it is estimated that constructing 32 GW of FGD along with 85 GW of SCR for the NOx SIP call and state regulations by 2005 would exceed the current market availability of boilermaker labor.

- It is estimated that there is enough boilermaker labor to complete 85 GW of SCR and up to 10 GW of scrubber retrofits out to 2005.

- More control installations could potentially be constructed by 2005 but it may affect the cost of compliance.

Electric System Reliability and Installation Experience

- **Reliability:**
  - Because most control installations are expected to be hooked-up during regularly scheduled outages, there should be no changes in system reliability.
  - A 5-20 year implementation time-frame should allow companies to schedule the hook-up of difficult retrofits over multiple outages.
  - The cap-and-trade aspect of the program allows emissions banking which will encourage a more smooth compliance schedule by providing incentives for early installations spreading out the hook-ups.
- **Clear Skies Builds on NOx SIP call Experience:**
  - Lessons learned as part of installation of SCRs for the NOx SIP call will make installations more efficient.
  - More boilermaker labor and engineering resources have been developed to install emission controls in response to the NOx SIP call. The retrofits required under this program will provide incentives to continue the use of these resources and possibly expand them.
  - Emerging multi-pollutant control technologies could provide more flexibility for installations. Some of these new technologies are expected to be available within the required retrofit period.