

# 21<sup>st</sup> Century Energy Plan: Modeling Results

**SIEMENS**

**October 11, 2006**



**Energy Business Solutions**

- Differences from last Update
- Modeling Results
- Scenario Summary



# Differences From Last Update

# Scenarios and Sensitivities Results Not Presented Previously

SIEMENS

## ■ Central Station Resources

- Base Conditions
- High Load
- Low Load
- Reduced Import
- Expanded Transmission

## ■ Emissions (Carbon)

- Base Conditions
- High Load
- Low Load
- Energy Efficiency
- Renewables w/ Energy Efficiency

## ■ Full Renewable Generation

- Base Conditions
- High Load
- Low Load

## ■ Energy Efficiency

- Base Conditions
- High Load
- Low Load
- Reduced EE Penetration

## ■ Energy Efficiency and Renewables

- Base Conditions
- High Load
- Low Load
- Reduced EE Penetration

## ■ Combustion Turbines Only

- Base Conditions
- High Load
- Low Load



# Scenarios and Sensitivities Corrected Results

SIEMENS

## ■ Central Station Resources

- Base Conditions
- High Load
- Low Load
- Reduced Import
- Expanded Transmission

## ■ Emissions (Carbon)

- Base Conditions
- High Load
- Low Load
- Energy Efficiency
- Renewables & Energy Efficiency

## ■ Renewable Generation

- Base Conditions
- High Load
- Low Load

## ■ Energy Efficiency

- Base Conditions
- High Load
- Low Load
- Reduced EE Penetration

## ■ Energy Efficiency and Renewables

- Base Conditions
- High Load
- Low Load
- Reduced EE Penetration

## ■ Combustion Turbines Only

- Base Conditions
- High Load
- Low Load

- Energy Efficiency (Conservation)
  - Effects of commercial building code changes were previously double counted
  - Total peak demand reduction is 2,801 MW (previously modeled as 3,879 MW)
  
- Renewable
  - Minor correction in modeled cost of CHP
  - The Renewable Base Load sensitivity previously did not include costs to Upper Peninsula in the September 26 report

# Modeling Results

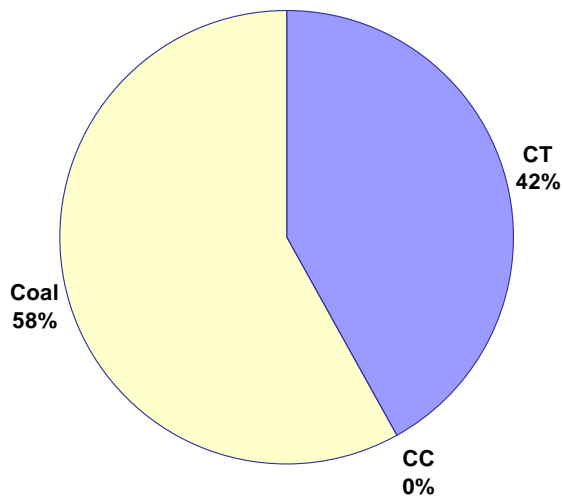


- Central Station Resources
- Plan Specifics
  - Average Annual Peak Demand Growth at 1.21%
  - Average Annual Energy Sales Growth at 1.29%
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

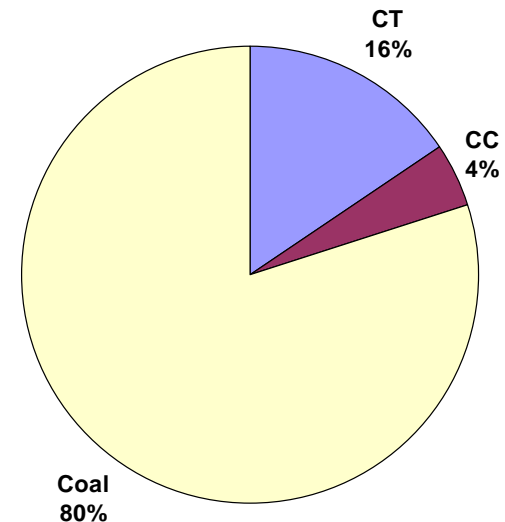
# Central Station Resources Scenario Expansion Plan Results

SIEMENS

■	2006 to 2015	
■	Capacity Additions	
■	CT	1,440 mW
■	CC	0 mW
■	PC	2,000 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	3,440 mW
■	Demand Growth	1.17 %
■	Reserve Margin	15.26 %
■	Plan Costs	
■	NPV Utility Cost	\$ 32,073.0 M
■	NPV Emissions	\$ 3,385.6 M
■	NPV CO2	\$ 0.00 M



■	2006 to 2025	
■	Capacity Additions	
■	CT	1,760 mW
■	CC	500 mW
■	PC	9,000 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	11,260 mW
■	Demand Growth	1.21 %
■	Reserve Margin	15.52 %
■	Plan Costs	
■	NPV Utility Cost	\$ 56,716.9 M
■	NPV Emissions	\$ 5,602.8 M
■	NPV CO2	\$ 0.00 M



# Central Station Resources Scenario Expansion Plan Schedule

SIEMENS

Central Station	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2 CT - METC			1	1						
7 CT - ITC			2		2	2				
2 CT - ATC2							1			
0 CC - METC										
1 CC - ITC										
0 CC - ATC2										
6 COAL - METC										
12 COAL - ITC							1	1	1	1
0 COAL - ATC2										
0 CFB - ATC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										
CT - ITC										1
CT - ATC2	1									
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC	1	1		1		1	1	1		
COAL - ITC	1		1	1	1	1	1	1	1	
COAL - ATC2										
CFB - ATC										



# Central Station Resources Scenario High Load Growth Sensitivity Overview

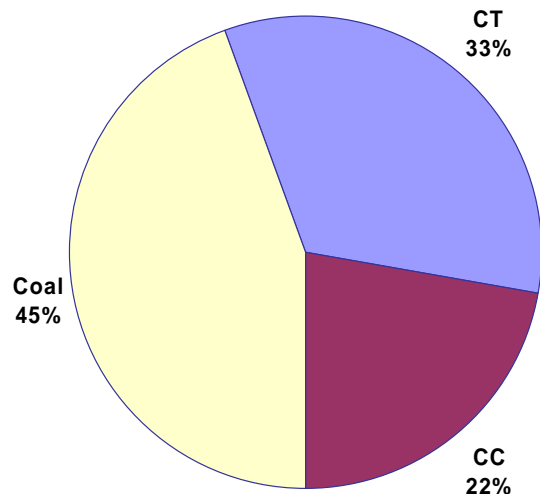
SIEMENS

- Central Station Resources with High Load Growth
- Plan Specifics
  - Average Annual Peak Demand Growth at 1.16%
  - Average Annual Energy Sales Growth at 1.69%
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

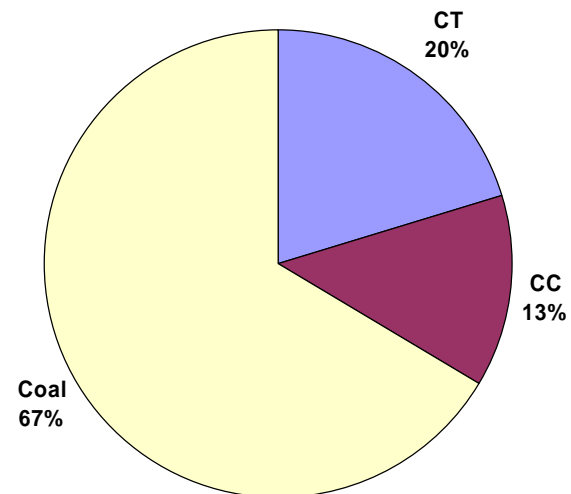
# Central Station Resources Scenario High Load Growth Sensitivity Expansion Plan Results

SIEMENS

■	2006 to 2015	
■	Capacity Additions	
■	CT	2,240 mW
■	CC	1,500 mW
■	PC	3,000 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	6,740 mW
■	Demand Growth	2.02 %
■	Reserve Margin	15.26 %
■	Plan Costs	
■	NPV Utility Cost	\$35,512.2 M
■	NPV Emissions	\$ 3,431.0 M
■	NPV CO <sub>2</sub>	\$ 0.0 M



■	2006 to 2025	
■	Capacity Additions	
■	CT	3,040 mW
■	CC	2,000 mW
■	PC	10,000 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	15,040 mW
■	Demand Growth	1.61 %
■	Reserve Margin	15.63 %
■	Plan Costs	
■	NPV Utility Cost	\$64,116.8 M
■	NPV Emissions	\$ 5,720.8 M
■	NPV CO <sub>2</sub>	\$ 0.0 M



# Central Station Resources Scenario High Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Central St. High Load	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
8 CT - METC			1	1	1	1	1			1
8 CT - ITC			2	1	2	1				
3 CT - ATC2							2			
0 CC - METC										
4 CC - ITC				1	1	1				
0 CC - ATC2										
8 COAL - METC							1	1		
12 COAL - ITC							1	1	1	1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC	1								1	
CT - ITC	1								1	
CT - ATC2				1						
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC		1		1		1	1	1	1	
COAL - ITC	1	1	1	1	1	1	1	1		
COAL - ATC2										
CFB - ATC2										



# Central Station Resources Scenario Low Load Growth Sensitivity Overview

SIEMENS

- Central Station Resources with Low Load Growth
- Plan Specifics
  - Average Annual Peak Demand Growth at 0.76%
  - Average Annual Energy Sales Growth at 0.84%
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Central Station Resources Scenario Low Load Growth Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

CT	160 mW
CC	0 mW
PC	500 mW
Nuclear	0 mW
Renewable	0 mW
Energy Efficiency	0 mW
<b>Total</b>	<b>660 mW</b>

Demand Growth	0.21 %
Reserve Margin	17.28 %

Plan Costs

NPV Utility Cost	\$28,873.2 M
NPV Emissions	\$ 3,356.5 M
NPV CO2	\$ 0.0 M

2006 to 2025

Capacity Additions

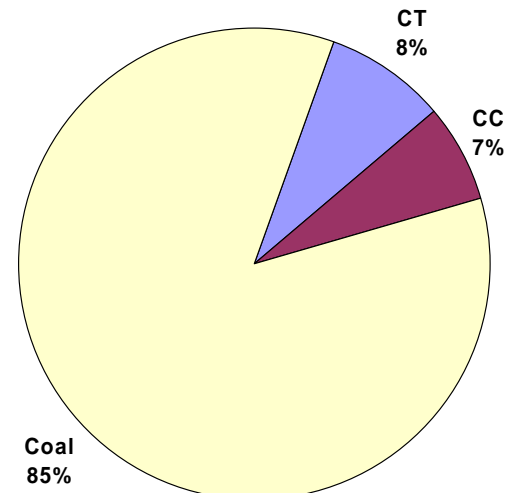
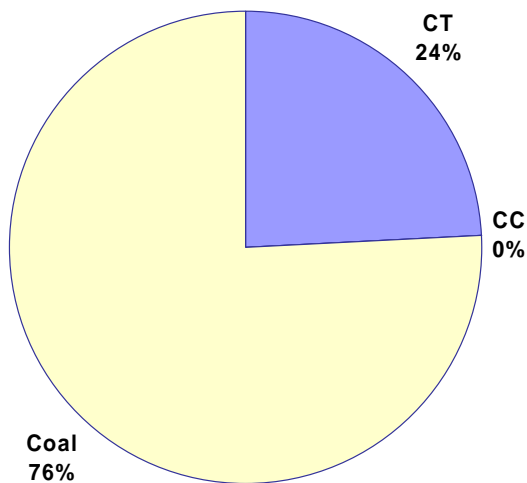
CT	640 mW
CC	500 mW
PC	6,500 mW
Nuclear	0 mW
Renewable	0 mW
Energy Efficiency	0 mW
<b>Total</b>	<b>7,640 mW</b>

Demand Growth	0.76 %
Reserve Margin	15.95 %

Plan Costs

NPV Utility Cost	\$49,811.6 M
NPV Emissions	\$ 5,470.6 M
NPV CO2	\$ 0.0 M



# Central Station Resources Scenario Low Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Central St. Low LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0 CT - METC										
2 CT - ITC										
2 CT - ATC2							1			
0 CC - METC										
1 CC - ITC										
0 CC - ATC2										
4 COAL - METC										
9 COAL - ITC										1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										
CT - ITC						1	1			
CT - ATC2										1
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC	1			1			1	1		
COAL - ITC		1	1	1	1	1	1	1	1	
COAL - ATC2										
CFB - ATC2										



# Central Station Resources Scenario Reduced Import Sensitivity Overview

SIEMENS

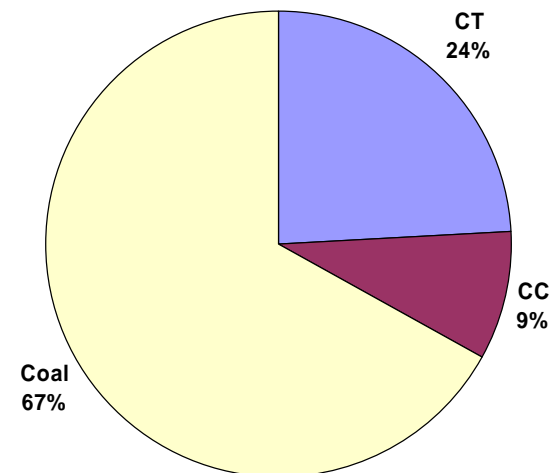
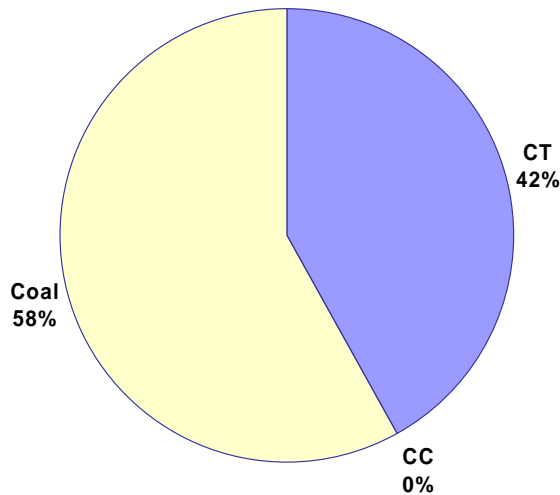
- Central Station Resources with Reduced Import Capability
- Plan Specifics
  - Base Load Growth
  - Reduced Import Capacity into MECS to 1,650 mW to account for energy flows to Ontario
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Central Station Resources Scenario Reduced Import Sensitivity Expansion Plan Results

SIEMENS

■	2006 to 2015	
■	Capacity Additions	
■	CT	1,440 mW
■	CC	0 mW
■	PC	2,000 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	3,440 mW
■	Demand Growth	1.17 %
■	Reserve Margin	15.26 %
■	Plan Costs	
■	NPV Utility Cost	\$32,169.2 M
■	NPV Emissions	\$ 3,373.6 M
■	NPV CO2	\$ 0.0 M

■	2006 to 2025	
■	Capacity Additions	
■	CT	2,720 mW
■	CC	1,000 mW
■	PC	7,500 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	11,220 mW
■	Demand Growth	1.21 %
■	Reserve Margin	15.40 %
■	Plan Costs	
■	NPV Utility Cost	\$57,004.8 M
■	NPV Emissions	\$ 5,492.4 M
■	NPV CO2	\$ 0.0 M



# Central Station Resources Scenario Reduced Import Sensitivity Expansion Plan Schedule

SIEMENS

Central St. Low Import	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
5 CT - METC			1		1	1				
10 CT - ITC			2	1	1	1				
2 CT - ATC2							1			
0 CC - METC										
2 CC - ITC										
0 CC - ATC2										
6 COAL - METC										
9 COAL - ITC							1	1	1	1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC								1		1
CT - ITC	1			1	1			1		1
CT - ATC2	1									
CC - METC										
CC - ITC								1	1	
CC - ATC2										
COAL - METC		1	1		1	1	1		1	
COAL - ITC	1		1	1		1	1			
COAL - ATC2										
CFB - ATC2										



# Central Station Resources Scenario Expanded Transmission Sensitivity Overview

SIEMENS

- Central Station Resources with Expanded Transmission
- Plan Specifics
  - Base Load Growth
  - Increase Transmission Capacity into ITC by 2,500 mW
  - Cost of Transmission Upgrades \$800M (\$640M charged to Michigan)
  - Reduce Minimum Reserve Margin Constraint to 12%
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Central Station Resources Scenario Expanded Transmission Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

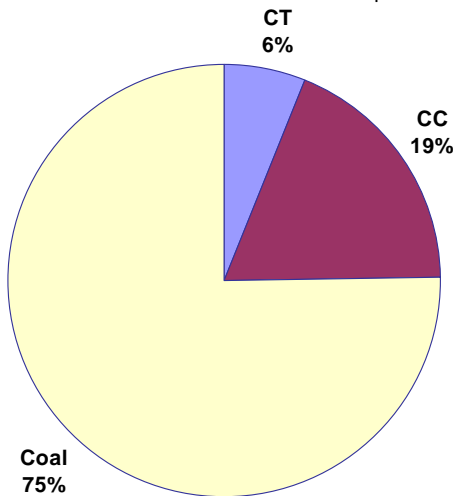
CT	160 mW
CC	500 mW
PC	2,000 mW
Nuclear	0 mW
Renewable	0 mW
Energy Efficiency	0 mW
<b>Total</b>	<b>2,660 mW</b>

Demand Growth 1.17 %

Reserve Margin 12.53 %

Plan Costs

NPV Utility Cost	\$32,329.1 M
NPV Emissions	\$ 3,400.3 M
NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

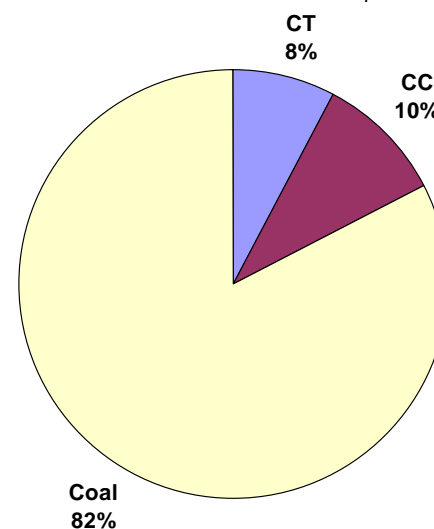
CT	800 mW
CC	1,000 mW
PC	8,500 mW
Nuclear	0 mW
Renewable	0 mW
Energy Efficiency	0 mW
<b>Total</b>	<b>10,300 mW</b>

Demand Growth 1.21 %

Reserve Margin 12.56 %

Plan Costs

NPV Utility Cost	\$57,085.5 M
NPV Emissions	\$ 5,627.2 M
NPV CO2	\$ 0.0 M



# Central Station Resources Scenario Expanded Transmission Sensitivity Expansion Plan Schedule

SIEMENS

Cent St Expand Trans		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	CT - METC										
3	CT - ITC										
2	CT - ATC2							1			
0	CC - METC										
2	CC - ITC					1					
0	CC - ATC2										
6	COAL - METC										
11	COAL - ITC							1	1	1	1
0	COAL - ATC2										
0	CFB - ATC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										
CT - ITC				1			1		1	
CT - ATC2	1									
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC		1	1		1		1	1	1	
COAL - ITC	1	1		1	1	1	1	1		
COAL - ATC2										
CFB - ATC										



- Emissions Case
- Plan Specifics
  - Base Load Growth
  - Carbon Tax
    - \$10/Ton in 2010
    - Grows to \$30/Ton in 2018
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
  - Nuclear
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - CFB – except UP

# Emissions (Carbon Case) Scenario Expansion Plan Results

2006 to 2015

Capacity Additions

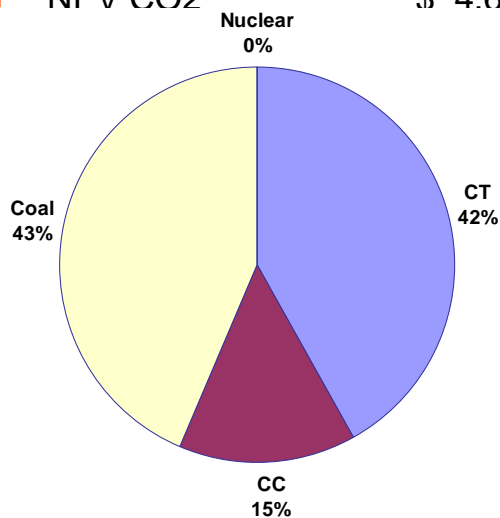
■ CT	1,440 mW
■ CC	500 mW
■ PC	1,500 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	0 mW
■ Total	3,440 mW

■ Demand Growth 1.17 %

■ Reserve Margin 15.26 %

Plan Costs

■ NPV Utility Cost	\$36,956.6 M
■ NPV Emissions	\$ 8,150.5 M
■ NPV CO2	\$ 4.688.2 M



2006 to 2025

Capacity Additions

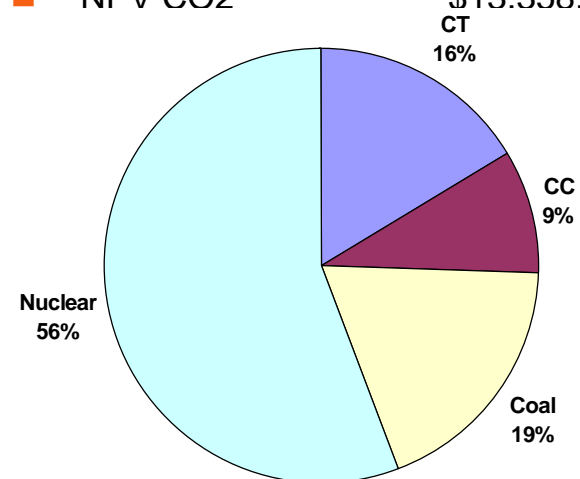
■ CT	1,760 mW
■ CC	1,000 mW
■ PC	2,000 mW
■ Nuclear	6,000 mW
■ Renewable	0 mW
■ Energy Efficiency	0 mW
■ Total	10,760 mW

■ Demand Growth 1.21 %

■ Reserve Margin 16.04 %

Plan Costs

■ NPV Utility Cost	\$70,752.2 M
■ NPV Emissions	\$18,991.7 M
■ NPV CO2	\$13.358.9 M



# Emissions (Carbon Case) Scenario Expansion Plan Schedule

SIEMENS

Emissions (Carbon)		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4	CT - METC			1		1	1				
5	CT - ITC			2	1	1	1				
2	CT - ATC2							1			
0	CC - METC										
2	CC - ITC										1
0	CC - ATC2										
1	COAL - METC										
3	COAL - ITC							1	1	1	
0	COAL - ATC2										
0	CFB - ATC2										
2	NUKE - METC										
4	NUKE - ITC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC	1									
CT - ITC										
CT - ATC2	1									
CC - METC										
CC - ITC	1									
CC - ATC2										
COAL - METC		1								
COAL - ITC										
COAL - ATC2										
CFB - ATC2										
NUKE - METC				1				1		
NUKE - ITC			1		1		1		1	



# Emissions (Carbon Case) Scenario High Load Growth Sensitivity Overview

SIEMENS

- Emissions with High Load Growth
- Plan Specifics
  - High Load Growth
  - Carbon Tax
    - \$10/Ton in 2010
    - Grows to \$30/Ton in 2018
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
  - Nuclear
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - CFB – except UP

# Emissions (Carbon Case) Scenario High Load Growth Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

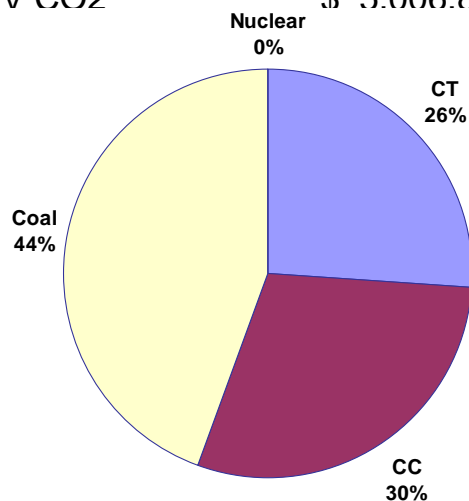
■ CT	1,760 mW
■ CC	2,000 mW
■ PC	3,000 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	0 mW
■ Total	6,760 mW

■ Demand Growth 2.02 %

■ Reserve Margin 15.33 %

Plan Costs

■ NPV Utility Cost	\$40,832.7 M
■ NPV Emissions	\$ 8,523.0 M
■ NPV CO2	\$ 5,006.8 M



2006 to 2025

Capacity Additions

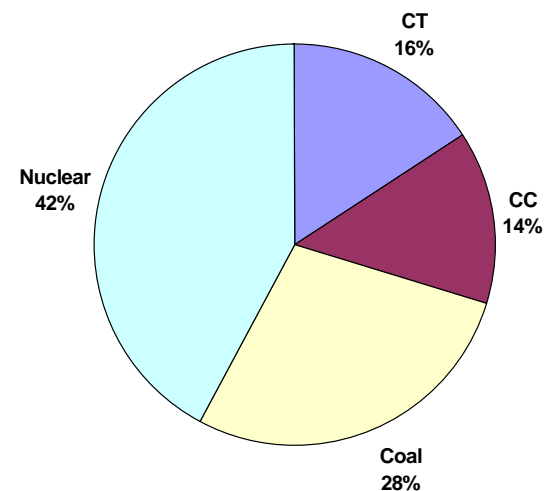
■ CT	2,240 mW
■ CC	2,000 mW
■ PC	4,000 mW
■ Nuclear	6,000 mW
■ Renewable	0 mW
■ Energy Efficiency	0 mW
■ Total	14,240 mW

■ Demand Growth 1.61 %

■ Reserve Margin 15.26 %

Plan Costs

■ NPV Utility Cost	\$79,492.7 M
■ NPV Emissions	\$20,788.7 M
■ NPV CO2	\$14,989.6 M



# Emissions (Carbon Case) Scenario High Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Emissions High LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4 CT - METC			1	1		1				
7 CT - ITC			2	1		1		1		1
3 CT - ATC2							2			
1 CC - METC					1					
3 CC - ITC				1	1	1				
0 CC - ATC2										
2 COAL - METC							1	1		
6 COAL - ITC							1	1	1	1
0 COAL - ATC2										
0 CFB - ATC2										
3 NUKE - METC										
3 NUKE - ITC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC							1			
CT - ITC	1									
CT - ATC2				1						
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC										
COAL - ITC	1	1								
COAL - ATC2										
CFB - ATC2										
NUKE - METC			1		1				1	
NUKE - ITC				1		1		1		



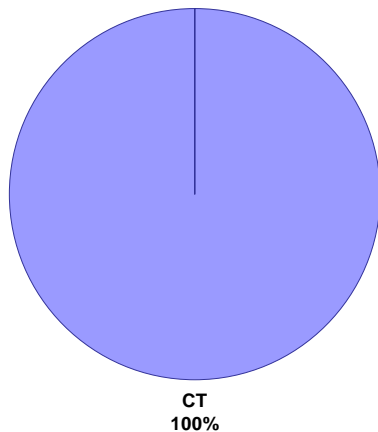
# Emissions (Carbon Case) Scenario Low Load Growth Sensitivity Overview

SIEMENS

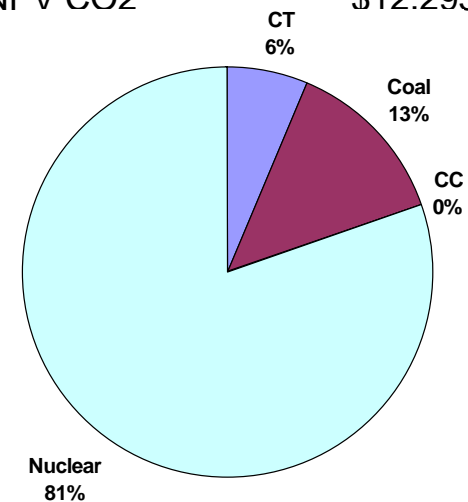
- Emissions Low Load Case
- Plan Specifics
  - Low Load Growth
  - Carbon Tax
    - \$10/Ton in 2010
    - Grows to \$30/Ton in 2018
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
  - Nuclear
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - CFB – except UP

# Emissions (Carbon Case) Scenario Low Load Growth Sensitivity Expansion Plan Results

■	2006 to 2015	
■	Capacity Additions	
■	CT	320 mW
■	CC	0 mW
■	PC	0 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	320 mW
■	Demand Growth	0.21 %
■	Reserve Margin	15.96 %
■	Plan Costs	
■	NPV Utility Cost	\$33,321.8 M
■	NPV Emissions	\$ 7,849.3 M
■	NPV CO2	\$ 4,420.0 M



■	2006 to 2025	
■	Capacity Additions	
■	CT	480 mW
■	CC	0 mW
■	PC	1,000 mW
■	Nuclear	6,000 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	7,480 mW
■	Demand Growth	0.76 %
■	Reserve Margin	17.69 %
■	Plan Costs	
■	NPV Utility Cost	\$62,254.7 M
■	NPV Emissions	\$17,817.7 M
■	NPV CO2	\$12,293.9 M



# Emissions (Carbon Case) Scenario Low Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Emissions Low LD		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	CT - METC										
1	CT - ITC										1
2	CT - ATC2							1			
0	CC - METC										
0	CC - ITC										
0	CC - ATC2										
1	COAL - METC										
1	COAL - ITC										
0	COAL - ATC2										
0	CFB - ATC2										
2	NUKE - METC										
4	NUKE - ITC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										
CT - ITC										
CT - ATC2										1
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC		1								
COAL - ITC	1									
COAL - ATC2										
CFB - ATC2										
NUKE - METC				1					1	
NUKE - ITC			1		1		1	1		



# Emissions (Carbon Case) Scenario Energy Efficiency Sensitivity Overview

SIEMENS

- Emissions with Energy Efficiency
- Plan Specifics
  - Base Load Growth
  - Carbon Tax
    - \$10/Ton in 2010
    - Grows to \$30/Ton in 2018
  - Energy Efficiency added to existing resource mix:
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
  - Nuclear
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - CFB – except UP



NewEnergy  
ASSOCIATES  
A Siemens Company



# Emissions (Carbon Case) Scenario Energy Efficiency Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

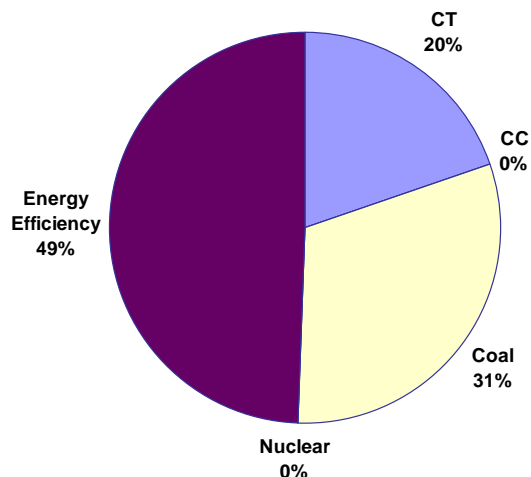
■ CT	640 mW
■ CC	0 mW
■ PC	1,000 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	1,609 mW
■ Total	3,249 mW

■ Demand Growth 0.46 %

■ Reserve Margin 16.09 %

Plan Costs

■ NPV Utility Cost	\$36,189.0 M
■ NPV Emissions	\$ 8,005.9 M
■ NPV CO2	\$ 4,558.8 M



2006 to 2025

Capacity Additions

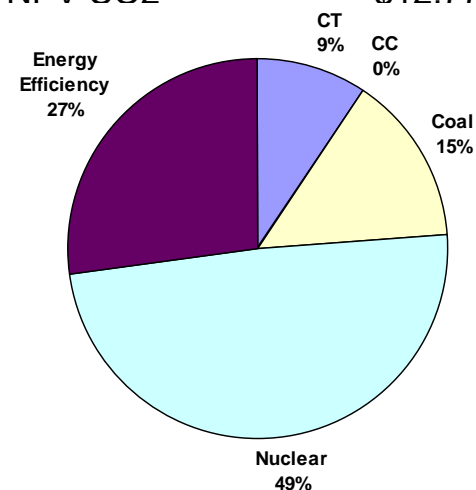
■ CT	960 mW
■ CC	0 mW
■ PC	1,500 mW
■ Nuclear	5,000 mW
■ Renewable	0 mW
■ Energy Efficiency	2,801 mW
■ Total	10,261 mW

■ Demand Growth 0.68 %

■ Reserve Margin 16.53 %

Plan Costs

■ NPV Utility Cost	\$66,707.5 M
■ NPV Emissions	\$18,347.7 M
■ NPV CO2	\$12,779.8 M



# Emissions (Carbon Case) Scenario Energy Efficiency Sensitivity Expansion Plan Schedule

SIEMENS

Emissions EE Only		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	CT - METC						1				
3	CT - ITC						1				1
2	CT - ATC2							1			
0	CC - METC										
0	CC - ITC										
0	CC - ATC2										
0	COAL - METC										
3	COAL - ITC							1			1
0	COAL - ATC2										
0	CFB - ATC2										
2	NUKE - METC										
3	NUKE - ITC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										
CT - ITC		1								
CT - ATC2								1		
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC										
COAL - ITC	1									
COAL - ATC2										
CFB - ATC2										
NUKE - METC					1		1			
NUKE - ITC			1	1				1		



# Emissions (Carbon Case) Scenario Energy Efficiency and Renewables Sensitivity Overview

SIEMENS

- Emissions with Energy Efficiency and Renewables
- Plan Specifics
  - Base Load Growth
  - Carbon Tax
    - \$10/Ton in 2010
    - Grows to \$30/Ton in 2018
  - Energy Efficiency and Renewables added to existing resource mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
    - 2.801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
  - Nuclear
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - CFB – except UP

# Emissions (Carbon Case) Scenario Energy Efficiency and Renewables Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

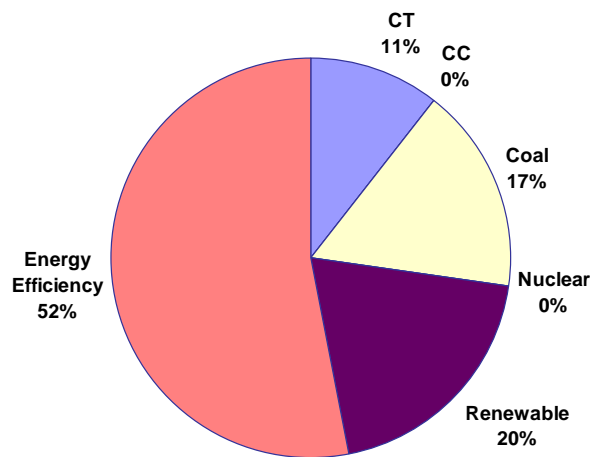
■ CT	320 mW
■ CC	0 mW
■ PC	500 mW
■ Nuclear	0 mW
■ Renewable	599 mW
■ Energy Efficiency	1,609 mW
■ Total	3,026 mW

■ Demand Growth 0.46 %

■ Reserve Margin 16.25 %

Plan Costs

■ NPV Utility Cost	\$36,203.2 M
■ NPV Emissions	\$ 7,870.5 M
■ NPV CO2	\$ 4,439.5 M



2006 to 2025

Capacity Additions

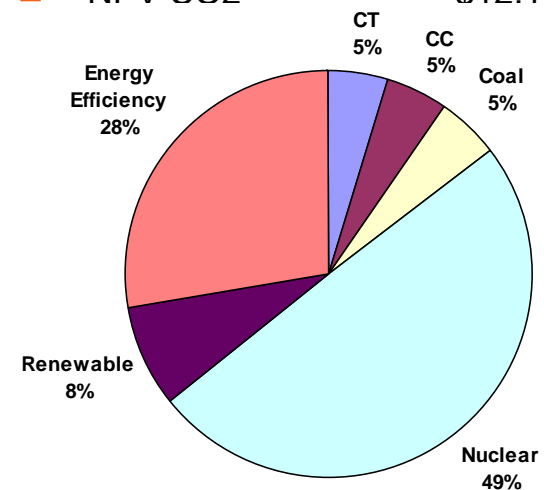
■ CT	480 mW
■ CC	500 mW
■ PC	500 mW
■ Nuclear	5,000 mW
■ Renewable	798 mW
■ Energy Efficiency	2,801 mW
■ Total	10,079 mW

■ Demand Growth 0.68 %

■ Reserve Margin 16.89 %

Plan Costs

■ NPV Utility Cost	\$66,179.2 M
■ NPV Emissions	\$17,618.7 M
■ NPV CO2	\$12,108.3 M



# Emissions (Carbon Case) Scenario Energy Efficiency and Renewables Sensitivity Expansion Plan Schedule

SIEMENS

Emissions Ren & EE		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0	CT - METC										
2	CT - ITC									1	
1	CT - ATC2							1			
0	CC - METC										
1	CC - ITC										
0	CC - ATC2										
1	COAL - METC										1
0	COAL - ITC										
0	COAL - ATC2										
0	CFB - ATC2										
1	NUKE - METC										
4	NUKE - ITC										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										
CT - ITC		1								
CT - ATC2										
CC - METC										
CC - ITC	1									
CC - ATC2										
COAL - METC										
COAL - ITC										
COAL - ATC2										
CFB - ATC2										
NUKE - METC				1						
NUKE - ITC			1		1		1	1		



- Renewable Generation Resources
- Plan Specifics
  - Base Load Growth
  - Renewable Resources “Hard Wired” into future generation mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Renewable Generation Scenario Expansion Plan Results

2006 to 2015

Capacity Additions

■ CT	1,280 mW
■ CC	0 mW
■ PC	1,500 mW
■ Nuclear	0 mW
■ Renewable	599 mW
■ Energy Efficiency	0 mW
■ Total	3,379 mW

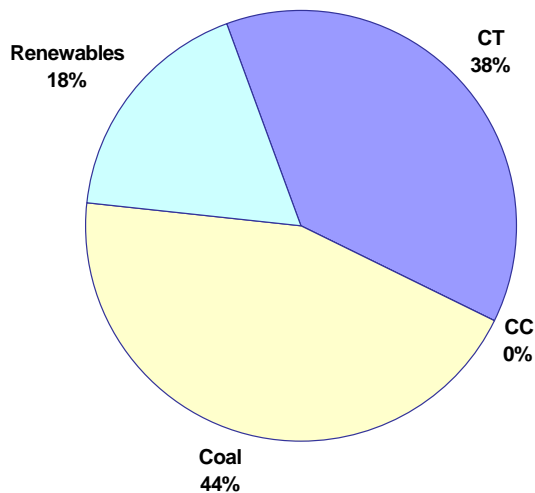
  

■ Demand Growth	1.17 %
■ Reserve Margin	15.97 %

Plan Costs

■ NPV Utility Cost	\$36,612.1 M
■ NPV Emissions	\$ 3,377.2 M
■ NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

■ CT	1,920 mW
■ CC	500 mW
■ PC	8,000 mW
■ Nuclear	0 mW
■ Renewable	798 mW
■ Energy Efficiency	0 mW
■ Total	11,218 mW

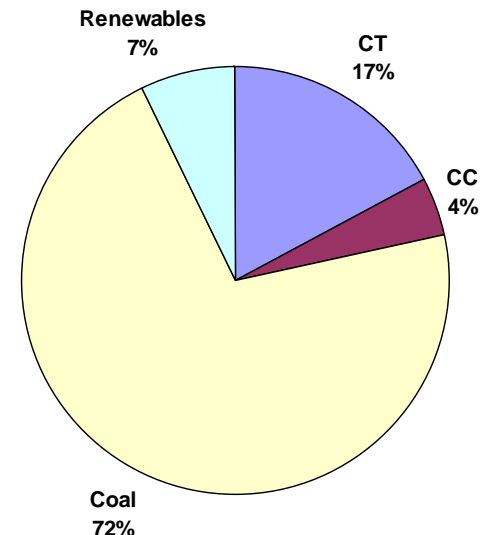
  

■ Demand Growth	1.21 %
■ Reserve Margin	16.28 %

Plan Costs

■ NPV Utility Cost	\$58,081.4 M
■ NPV Emissions	\$ 5,540.9 M
■ NPV CO2	\$ 0.0 M



# Renewable Generation Scenario Expansion Plan Schedule

SIEMENS

Renewables	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4 CT - METC			1							
7 CT - ITC				1	2	1			1	1
1 CT - ATC2							1			
0 CC - METC										
1 CC - ITC										
0 CC - ATC2										
5 COAL - METC										
11 COAL - ITC							1	1		1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC						1	1			1
CT - ITC									1	
CT - ATC2										
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC			1	1			1	1	1	
COAL - ITC	1	1	1	1	1	1	1	1		
COAL - ATC2										
CFB - ATC2										



# Renewable Generation Scenario High Load Growth Sensitivity Overview

SIEMENS

- Renewable Generation Resources with High Load Growth
- Plan Specifics
  - High Load Growth
  - Renewable Resources “Hard Wired” into future generation mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP



# Renewable Generation Scenario High Load Growth Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

- CT 1,600 mW
- CC 1,500 mW
- PC 3,000 mW
- Nuclear 0 mW
- Renewable 599 mW
- Energy Efficiency 0 mW

Total 6,699 mW

Demand Growth 2.02 %

Reserve Margin 15.98 %

Plan Costs

- NPV Utility Cost \$36,034.6 M
- NPV Emissions \$ 3,424.3 M
- NPV CO2 \$ 0.0 M

2006 to 2025

Capacity Additions

- CT 2,400 mW
- CC 2,000 mW
- PC 9,500 mW
- Nuclear 0 mW
- Renewable 798 mW
- Energy Efficiency 0 mW

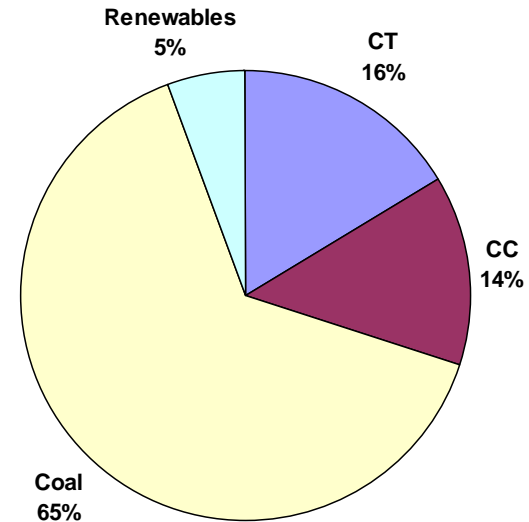
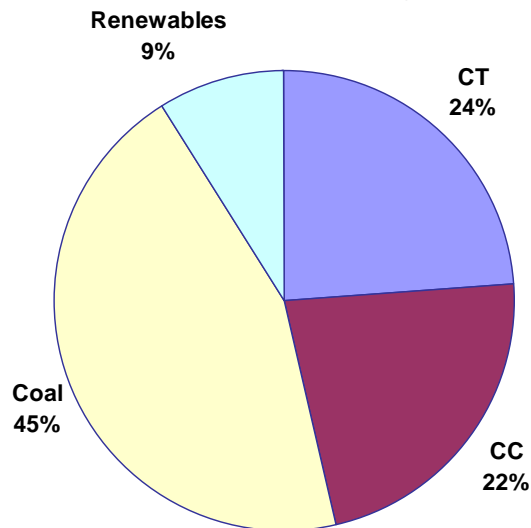
Total 14,698 mW

Demand Growth 1.61 %

Reserve Margin 15.48 %

Plan Costs

- NPV Utility Cost \$65,343.3 M
- NPV Emissions \$ 5,687.4 M
- NPV CO2 \$ 0.0 M



# Renewable Generation Scenario High Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Renewables High LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
7 CT - METC			1		1	1		1		
6 CT - ITC			1	1	1	1		1		
2 CT - ATC2							1			
0 CC - METC										
4 CC - ITC				1	1	1				
0 CC - ATC2										
7 COAL - METC							1		1	
12 COAL - ITC							1	1	1	1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC						1	1			1
CT - ITC									1	
CT - ATC2			1							
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC			1	1			1	1	1	
COAL - ITC	1	1	1	1	1	1	1	1		
COAL - ATC2										
CFB - ATC2										



# Renewable Generation Scenario Low Load Growth Sensitivity Overview

SIEMENS

- Renewable Generation Resources with Low Load Growth
- Plan Specifics
  - Low Load Growth
  - Renewable Resources “Hard Wired” into future generation mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Renewable Generation Scenario Low Load Growth Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

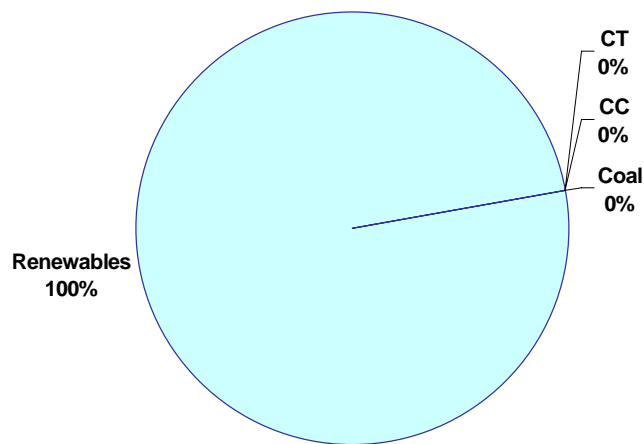
■ CT	0 mW
■ CC	0 mW
■ PC	0 mW
■ Nuclear	0 mW
■ Renewable	599 mW
■ Energy Efficiency	0 mW
■ Total	599 mW

■ Demand Growth	0.21 %
■ Reserve Margin	18.07 %

Plan Costs

■ NPV Utility Cost	\$29,541.5 M
■ NPV Emissions	\$ 3,348.2 M
■ NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

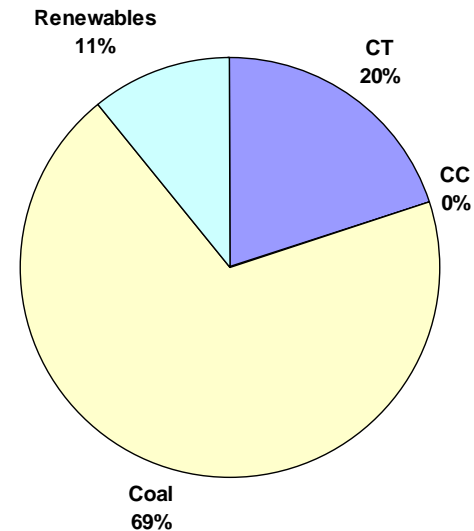
■ CT	1,440 mW
■ CC	0 mW
■ PC	5,000 mW
■ Nuclear	0 mW
■ Renewable	798 mW
■ Energy Efficiency	0 mW
■ Total	7,238 mW

■ Demand Growth	0.76 %
■ Reserve Margin	15.55 %

Plan Costs

■ NPV Utility Cost	\$51,382.5 M
■ NPV Emissions	\$ 5,382.1 M
■ NPV CO2	\$ 0.0 M



# Renewable Generation Scenario Low Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Renewables	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3 CT - METC										
6 CT - ITC										
0 CT - ATC2										
0 CC - METC										
0 CC - ITC										
0 CC - ATC2										
2 COAL - METC										
8 COAL - ITC										
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC				1		1				1
CT - ITC			1	1		1	1	1		1
CT - ATC2										
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC							1		1	
COAL - ITC		1	1	1	1	1	1	1	1	
COAL - ATC2										
CFB - ATC2										

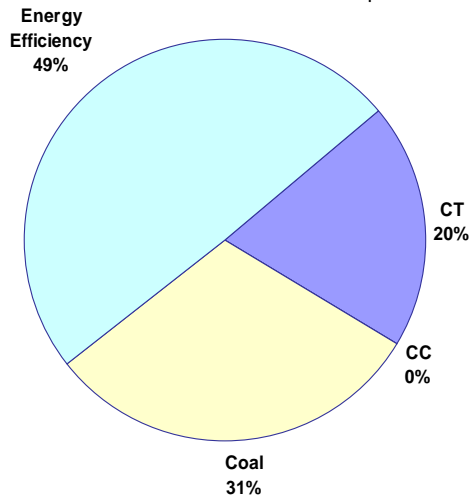


- Energy Efficiency
- Plan Specifics
  - Base Load Growth starting point
  - Energy Efficiency Added to existing resource mix:
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

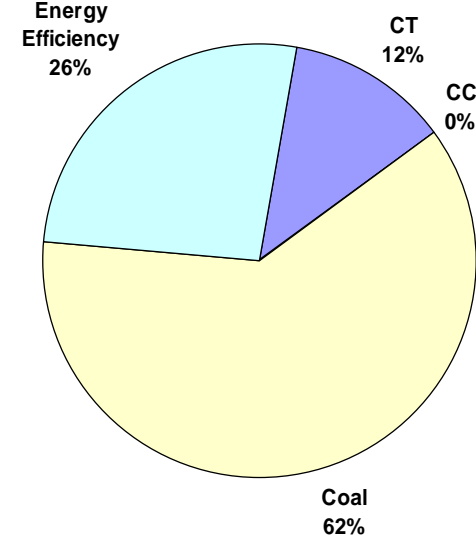
# Energy Efficiency Scenario Expansion Plan Results

SIEMENS

■	2006 to 2015	
■	Capacity Additions	
■	CT	640 mW
■	CC	0 mW
■	PC	1,000 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	1,609 mW
■	<b>Total</b>	<b>3,249 mW</b>
■	Demand Growth	0.46 %
■	Reserve Margin	16.09 %
■	Plan Costs	
■	NPV Utility Cost	\$31,510.1 M
■	NPV Emissions	\$ 3,307.1 M
■	NPV CO2	\$ 0.0 M



■	2006 to 2025	
■	Capacity Additions	
■	CT	1,280 mW
■	CC	0 mW
■	PC	6,500 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	2,801 mW
■	<b>Total</b>	<b>10,581 mW</b>
■	Demand Growth	0.68 %
■	Reserve Margin	15.73 %
■	Plan Costs	
■	NPV Utility Cost	\$53,794.5 M
■	NPV Emissions	\$ 5,494.7 M
■	NPV CO2	\$ 0.0 M



# Energy Efficiency Scenario Expansion Plan Schedule

SIEMENS

Energy Efficiency	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3 CT - METC						1				
3 CT - ITC						1				1
2 CT - ATC2							1			
0 CC - METC										
0 CC - ITC										
0 CC - ATC2										
4 COAL - METC										
9 COAL - ITC							1			1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC									1	1
CT - ITC										1
CT - ATC2								1		
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC					1	1	1		1	
COAL - ITC	1	1	1	1		1	1	1		
COAL - ATC2										
CFB - ATC2										



# Energy Efficiency Scenario High Load Growth Sensitivity Overview

SIEMENS

- Energy Efficiency with High Load Growth
- Plan Specifics
  - High Load Growth starting point
  - Energy Efficiency Added to existing resource mix:
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Energy Efficiency Scenario High Load Growth Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

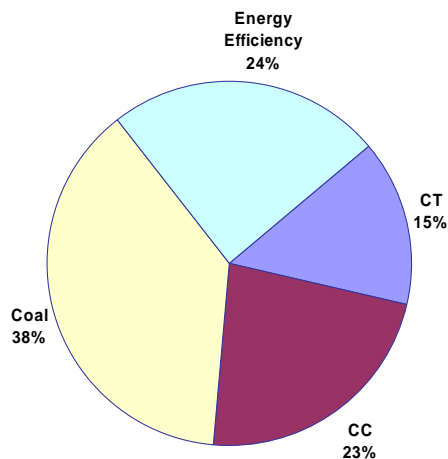
■ CT	960 mW
■ CC	1,500 mW
■ PC	2,500 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	1,609 mW
■ Total	6,569 mW

■ Demand Growth 1.37 %

■ Reserve Margin 16.08 %

Plan Costs

■ NPV Utility Cost	\$34,918.3 M
■ NPV Emissions	\$ 3,421.6 M
■ NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

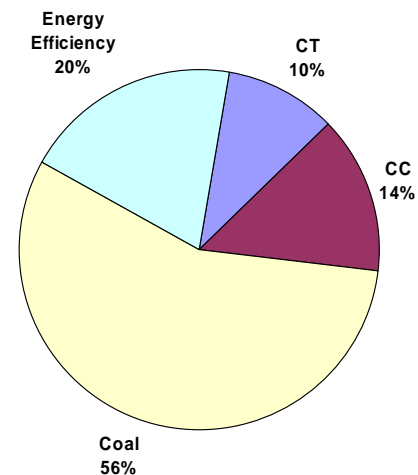
■ CT	1,440 mW
■ CC	2,000 mW
■ PC	8,000 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	2,801 mW
■ Total	14,241 mW

■ Demand Growth 1.13 %

■ Reserve Margin 15.45 %

Plan Costs

■ NPV Utility Cost	\$61,040.0 M
■ NPV Emissions	\$ 5,644.4 M
■ NPV CO2	\$ 0.0 M



# Energy Efficiency Scenario High Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Energy Eff High LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4 CT - METC					1	1				
3 CT - ITC					1	1				
2 CT - ATC2							2			
1 CC - METC										
3 CC - ITC				1	1	1				
0 CC - ATC2										
6 COAL - METC							1		1	
10 COAL - ITC							1	1		1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC								1	1	
CT - ITC				1						
CT - ATC2										
CC - METC										1
CC - ITC										
CC - ATC2										
COAL - METC		1				1	1		1	
COAL - ITC	1		1	1	1	1	1	1		
COAL - ATC2										
CFB - ATC2										



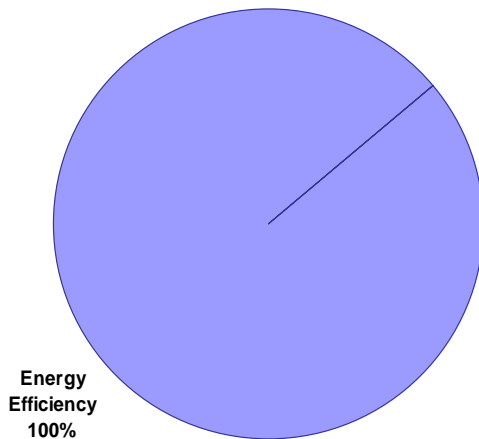
# Energy Efficiency Scenario Low Load Growth Sensitivity Overview

SIEMENS

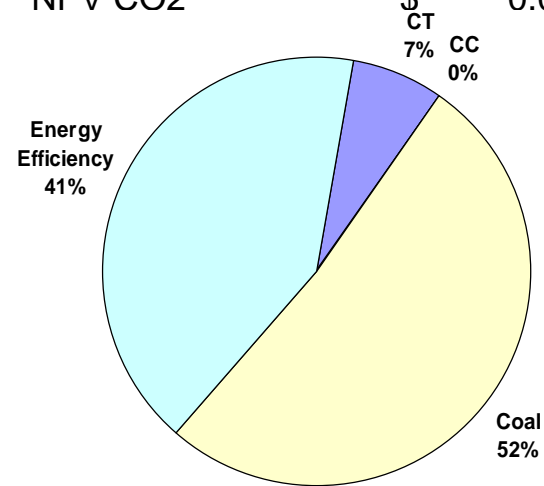
- Energy Efficiency with Low Load Growth
- Plan Specifics
  - Low Load Growth starting point
  - Energy Efficiency Added to existing resource mix
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Energy Efficiency Scenario Low Load Growth Sensitivity Expansion Plan Results

■	2006 to 2015	
■	Capacity Additions	
■	CT	0 mW
■	CC	0 mW
■	PC	0 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	1,609 mW
■	Total	1,609 mW
■	Demand Growth	-0.57 %
■	Reserve Margin	23.11 %
■	Plan Costs	
■	NPV Utility Cost	\$28,638.7 M
■	NPV Emissions	\$ 3,350.5 M
■	NPV CO2	\$ 0.0 M



■	2006 to 2025	
■	Capacity Additions	
■	CT	480 mW
■	CC	0 mW
■	PC	3,500 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	2,801 mW
■	Total	6,781 mW
■	Demand Growth	0.17 %
■	Reserve Margin	15.53 %
■	Plan Costs	
■	NPV Utility Cost	\$47,384.1 M
■	NPV Emissions	\$ 5,348.2 M
■	NPV CO2	\$ 0.0 M



# Energy Efficiency Scenario Low Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

Energy Eff Low LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1 CT - METC										
1 CT - ITC										
1 CT - ATC2										
0 CC - METC										
0 CC - ITC										
0 CC - ATC2										
2 COAL - METC										
5 COAL - ITC										
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										1
CT - ITC										1
CT - ATC2								1		
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC				1			1			
COAL - ITC					1	1	1	1	1	
COAL - ATC2										
CFB - ATC2										



# Energy Efficiency Scenario

## Reduced EE Penetration Sensitivity Overview

SIEMENS

- Energy Efficiency with Base Load Growth
- Plan Specifics
  - Base Load Growth starting point
  - Energy Efficiency Added to existing resource mix
    - 1,920 mW Peak Demand reduction
    - 8,327 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Energy Efficiency Scenario Reduced EE Penetration Sensitivity Expansion Plan Results

2006 to 2015

Capacity Additions

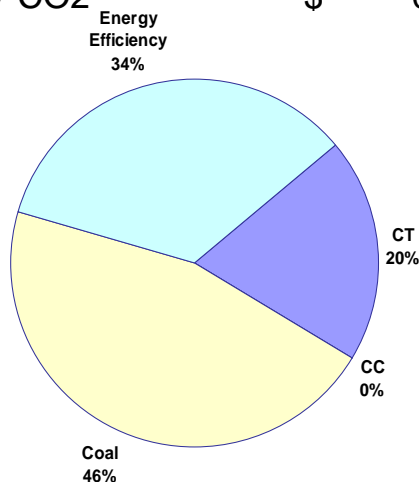
■ CT	640 mW
■ CC	0 mW
■ PC	1,500 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	1,127 mW
■ Total	3,267 mW

■ Demand Growth 0.67 %

■ Reserve Margin 15.69 %

Plan Costs

■ NPV Utility Cost	\$32,208.7 M
■ NPV Emissions	\$ 3,379.9 M
■ NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

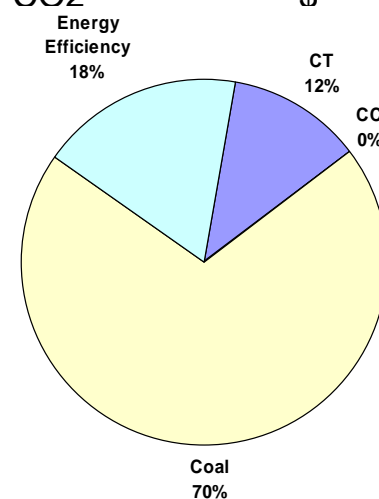
■ CT	1,280 mW
■ CC	0 mW
■ PC	7,500 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	1,920 mW
■ Total	10,700 mW

■ Demand Growth 0.85 %

■ Reserve Margin 15.36 %

Plan Costs

■ NPV Utility Cost	\$55,765.2 M
■ NPV Emissions	\$ 5,542.4 M
■ NPV CO2	\$ 0.0 M



# Energy Efficiency Scenario Reduced EE Penetration Sensitivity Expansion Plan Schedule

SIEMENS

Energy Eff Red Pen	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2 CT - METC						1				
4 CT - ITC					1	1				
2 CT - ATC2							1			
0 CC - METC										
0 CC - ITC										
0 CC - ATC2										
5 COAL - METC										
10 COAL - ITC							1	1		1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC										1
CT - ITC						1				1
CT - ATC2						1				
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC		1	1				1	1	1	
COAL - ITC	1		1	1	1	1	1	1		
COAL - ATC2										
CFB - ATC2										



- Energy Efficiency with Renewable Generation Resources
- Plan Specifics
  - Base Load Growth starting point
  - Energy Efficiency and Renewables added to existing resource mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Energy Efficiency and Renewables Scenario Expansion Plan Results

2006 to 2015

Capacity Additions

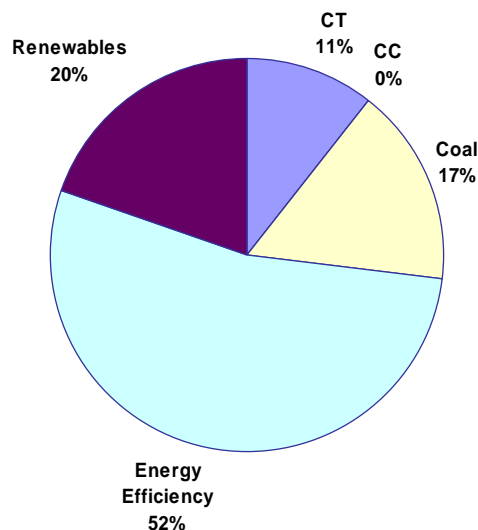
■ CT	320 mW
■ CC	0 mW
■ PC	500 mW
■ Nuclear	0 mW
■ Renewable	599 mW
■ Energy Efficiency	1,609 mW
■ Total	3,028 mW

■ Demand Growth 0.46 %

■ Reserve Margin 16.25 %

Plan Costs

■ NPV Utility Cost	\$32,103.3 M
■ NPV Emissions	\$ 3,354.9 M
■ NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

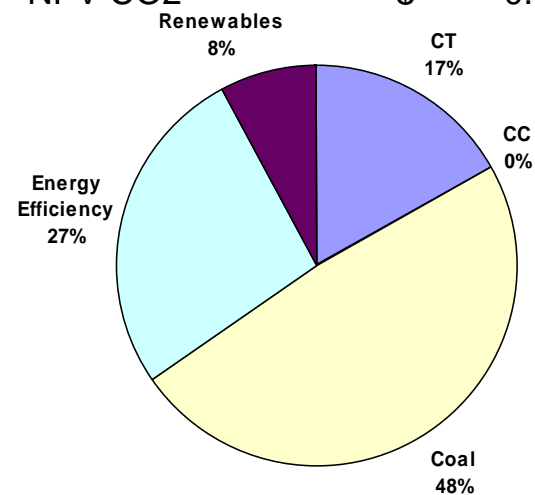
■ CT	1,760 mW
■ CC	0 mW
■ PC	5,000 mW
■ Nuclear	0 mW
■ Renewable	798 mW
■ Energy Efficiency	2,801 mW
■ Total	10,359 mW

■ Demand Growth 0.68 %

■ Reserve Margin 15.95 %

Plan Costs

■ NPV Utility Cost	\$55,207.9 M
■ NPV Emissions	\$ 5,411.1 M
■ NPV CO2	\$ 0.0 M



# Energy Efficiency and Renewables Scenario Expansion Plan Schedule

SIEMENS

Energy Eff & Renew	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
5 CT - METC										
5 CT - ITC									1	
1 CT - ATC2							1			
0 CC - METC										
0 CC - ITC										
0 CC - ATC2										
1 COAL - METC										
9 COAL - ITC										1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC	1			1		1			1	1
CT - ITC	1					1		1		1
CT - ATC2										
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC							1			
COAL - ITC		1	1	1	1	1	1	1	1	
COAL - ATC2										
CFB - ATC2										



# Energy Efficiency and Renewables Scenario High Load Growth Sensitivity Overview

SIEMENS

- Energy Efficiency with Renewable Generation Resources
- Plan Specifics
  - High Load Growth starting point
  - Energy Efficiency and Renewables added to existing resource mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP



# Energy Efficiency and Renewables Scenario High Load Growth Sensitivity Expansion Plan Results

SIEMENS

## 2006 to 2015

### Capacity Additions

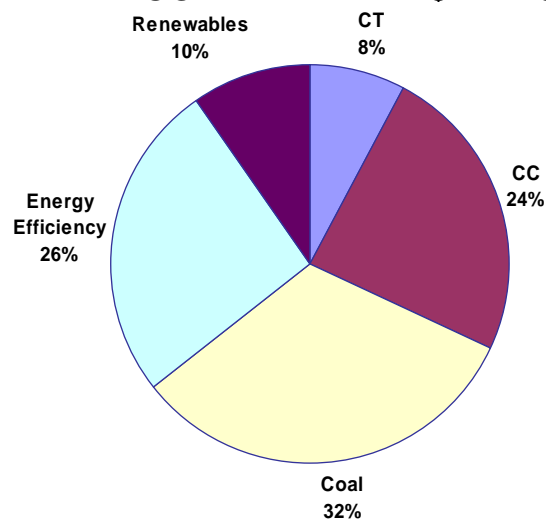
■ CT	480 mW
■ CC	1,500 mW
■ PC	2,000 mW
■ Nuclear	0 mW
■ Renewable	599 mW
■ Energy Efficiency	1,609 mW
■ Total	6,188 mW

■ Demand Growth 1.37 %

■ Reserve Margin 15.69 %

### Plan Costs

■ NPV Utility Cost	\$35,459.6 M
■ NPV Emissions	\$ 3,405.9 M
■ NPV CO2	\$ 0.0 M



## 2006 to 2025

### Capacity Additions

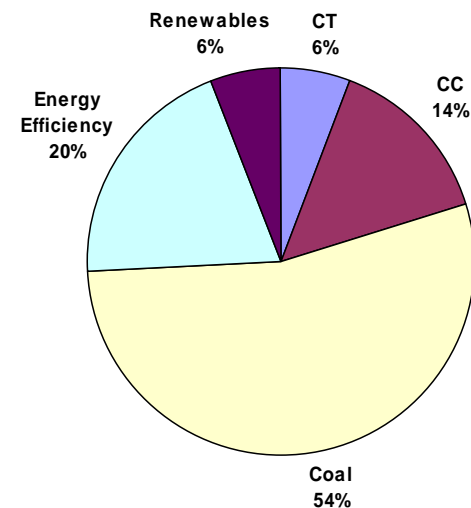
■ CT	800 mW
■ CC	2,000 mW
■ PC	7,500 mW
■ Nuclear	0 mW
■ Renewable	798 mW
■ Energy Efficiency	2,801 mW
■ Total	13,899 mW

■ Demand Growth 1.13 %

■ Reserve Margin 15.28 %

### Plan Costs

■ NPV Utility Cost	\$62,365.1 M
■ NPV Emissions	\$ 5,598.0 M
■ NPV CO2	\$ 0.0 M



# Energy Efficiency and Renewables Scenario High Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

EE & Renew High LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3 CT - METC						1				
1 CT - ITC							1			
1 CT - ATC2							1			
0 CC - METC										
4 CC - ITC				1	1	1				
0 CC - ATC2										
5 COAL - METC								1		
10 COAL - ITC							1		1	1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC								1	1	
CT - ITC										
CT - ATC2										
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC		1		1			1		1	
COAL - ITC	1		1	1	1	1	1	1		
COAL - ATC2										
CFB - ATC2										



# Energy Efficiency and Renewables Scenario Low Load Growth Sensitivity Overview

SIEMENS

- Energy Efficiency with Renewable Generation Resources
- Plan Specifics
  - Low Load Growth starting point
  - Energy Efficiency and Renewables added to existing resource mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
    - 2,801 mW Peak Demand reduction
    - 14,430 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP

# Energy Efficiency and Renewables Scenario Low Load Growth Sensitivity Expansion Plan Results

SIEMENS

2006 to 2015

Capacity Additions

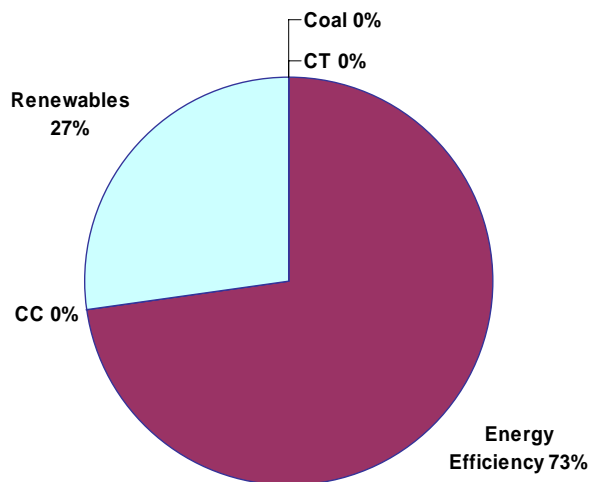
■ CT	0 mW
■ CC	0 mW
■ PC	0 mW
■ Nuclear	0 mW
■ Renewable	599 mW
■ Energy Efficiency	1,609 mW
■ Total	2,208 mW

■ Demand Growth -0.57 %

■ Reserve Margin 26.70 %

Plan Costs

■ NPV Utility Cost	\$29,351.7 M
■ NPV Emissions	\$ 3,346.6 M
■ NPV CO2	\$ 0.0 M



2006 to 2025

Capacity Additions

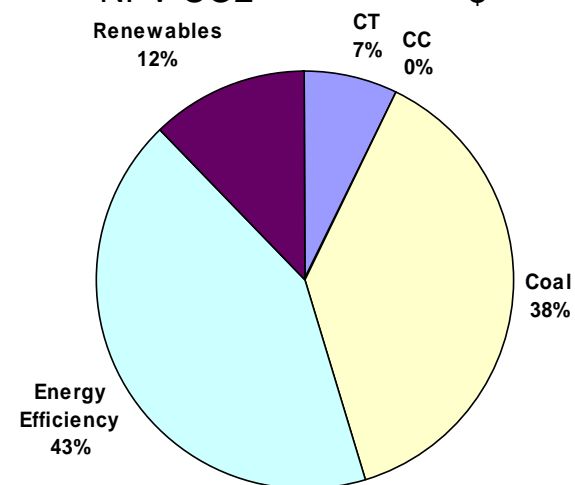
■ CT	480 mW
■ CC	0 mW
■ PC	2,500 mW
■ Nuclear	0 mW
■ Renewable	798 mW
■ Energy Efficiency	2,801 mW
■ Total	6,579 mW

■ Demand Growth 0.17 %

■ Reserve Margin 15.86 %

Plan Costs

■ NPV Utility Cost	\$48,992.6 M
■ NPV Emissions	\$ 5,306.8 M
■ NPV CO2	\$ 0.0 M



# Energy Efficiency and Renewables Scenario Low Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

EE & Renew Low LD	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
2 CT - METC										
1 CT - ITC										
0 CT - ATC2										
0 CC - METC										
0 CC - ITC										
0 CC - ATC2										
1 COAL - METC										
4 COAL - ITC										
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC									1	1
CT - ITC										1
CT - ATC2										
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC							1			
COAL - ITC						1	1	1	1	
COAL - ATC2										
CFB - ATC2										



# Energy Efficiency and Renewables Scenario Reduced EE Penetration Sensitivity Overview

SIEMENS

- Energy Efficiency with Renewable Generation Resources
- Plan Specifics
  - Base Load Growth starting point
  - Energy Efficiency and Renewables added to existing resource mix:
    - 1,354 mW of Renewable Resources
    - 798 mW Firm Renewable Capacity
    - 1,920 mW Peak Demand reduction
    - 8,327 gWh Energy Sales reductions
  - Central Station resource additions re-optimized
- Alternatives Considered
  - 160 mW CT – all regions
  - 500 mW CC – all regions
  - 500 mW PC – all regions
  - 150 mW CFB – UP only
- Alternatives Screened Out
  - IGCC
  - IGCC – PRB coal
  - Nuclear
  - CFB – except UP



# Energy Efficiency and Renewables Scenario Reduced EE Penetration Sensitivity Expansion Plan Results

SIEMENS

## 2006 to 2015

### Capacity Additions

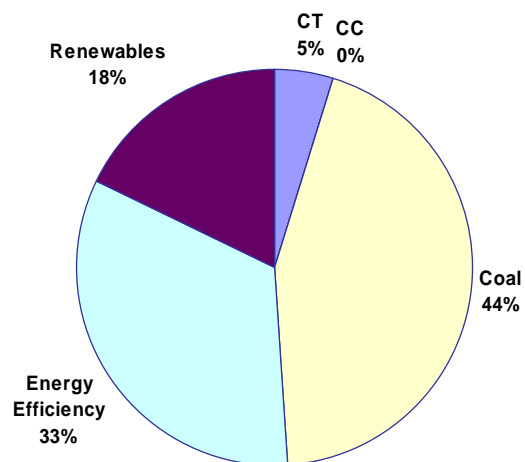
CT	160 mW
CC	0 mW
PC	1,500 mW
Nuclear	0 mW
Renewable	599 mW
Energy Efficiency	1,127 mW
<b>Total</b>	<b>3,386 mW</b>

Demand Growth 0.67 %

Reserve Margin 17.10 %

### Plan Costs

NPV Utility Cost	\$32,797.3 M
NPV Emissions	\$ 3,374.0 M
NPV CO2	\$ 0.0 M



## 2006 to 2025

### Capacity Additions

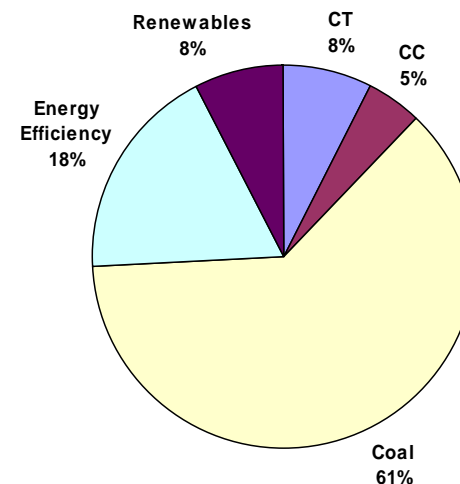
CT	800 mW
CC	500 mW
PC	6,500 mW
Nuclear	0 mW
Renewable	798 mW
Energy Efficiency	1,920 mW
<b>Total</b>	<b>10,518 mW</b>

Demand Growth 0.85 %

Reserve Margin 15.70 %

### Plan Costs

NPV Utility Cost	\$57,130.8 M
NPV Emissions	\$ 5,504.4 M
NPV CO2	\$ 0.0 M



# Energy Efficiency and Renewables Scenario Reduced EE Penetration Sensitivity Expansion Plan Schedule

SIEMENS

EE Red Pen & Renew	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1 CT - METC										
3 CT - ITC										
1 CT - ATC2							1			
0 CC - METC										
1 CC - ITC										
0 CC - ATC2										
4 COAL - METC										
9 COAL - ITC							1		1	1
0 COAL - ATC2										
0 CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC						1				
CT - ITC						1		1	1	
CT - ATC2										
CC - METC										
CC - ITC										1
CC - ATC2										
COAL - METC			1			1	1		1	
COAL - ITC	1		1	1	1		1	1		
COAL - ATC2										
CFB - ATC2										



- Combustion Turbines Only
- Plan Specifics
  - Base Load Growth
- Alternatives Considered
  - 160 mW CT
- Alternatives Not Considered
  - CC
  - PC
  - CFB
  - IGCC
  - IGCC – PRB coal
  - Nuclear

# Combustion Turbines Only Scenario Expansion Plan Results

SIEMENS

■	2006 to 2015	
■	Capacity Additions	
■	CT	3,520 mW
■	CC	0 mW
■	PC	0 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	3,520 mW
■	Demand Growth	1.17 %
■	Reserve Margin	15.54 %
■	Plan Costs	
■	NPV Utility Cost	\$32,126.9 M
■	NPV Emissions	\$ 3,354.5 M
■	NPV CO2	\$ 0.0 M

■	2006 to 2025	
■	Capacity Additions	
■	CT	11,200 mW
■	CC	0 mW
■	PC	0 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	11,200 mW
■	Demand Growth	1.21 %
■	Reserve Margin	15.34 %
■	Plan Costs	
■	NPV Utility Cost	\$58,987.6 M
■	NPV Emissions	\$ 5,348.5 M
■	NPV CO2	\$ 0.0 M



# Combustion Turbines Only Scenario Expansion Plan Schedule

SIEMENS

CT's Only		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
20	CT - METC			1	1	1					1
48	CT - ITC			2		1	2	3	3	2	4
2	CT - ATC2							1			
0	CC - METC										
0	CC - ITC										
0	CC - ATC2										
0	COAL - METC										
0	COAL - ITC										
0	COAL - ATC2										
0	CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC		2	1		4	2	4	2		1
CT - ITC	3	2	4	5		4	2	4	5	2
CT - ATC2	1									
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC										
COAL - ITC										
COAL - ATC2										
CFB - ATC2										



# Combustion Turbines Only Scenario High Load Growth Sensitivity Overview

SIEMENS

- Combustion Turbines Only
- Plan Specifics
  - High Load Growth
- Alternatives Considered
  - 160 mW CT
- Alternatives Not Considered
  - CC
  - PC
  - CFB
  - IGCC
  - IGCC – PRB coal
  - Nuclear

# Combustion Turbines Only Scenario High Load Growth Sensitivity Expansion Plan Results

SIEMENS

■	2006 to 2015	
■	Capacity Additions	
■	CT	6,720 mW
■	CC	0 mW
■	PC	0 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	6,720 mW
■	Demand Growth	2.02 %
■	Reserve Margin	15.20 %
■	Plan Costs	
■	NPV Utility Cost	\$35,630.2 M
■	NPV Emissions	\$ 3,362.5 M
■	NPV CO2	\$ 0.0 M

■	2006 to 2025	
■	Capacity Additions	
■	CT	14,880 mW
■	CC	0 mW
■	PC	0 mW
■	Nuclear	0 mW
■	Renewable	0 mW
■	Energy Efficiency	0 mW
■	Total	14,880 mW
■	Demand Growth	1.61 %
■	Reserve Margin	15.18 %
■	Plan Costs	
■	NPV Utility Cost	\$68,096.6 M
■	NPV Emissions	\$ 5,410.1 M
■	NPV CO2	\$ 0.0 M

# Combustion Turbines Only Scenario High Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

CT Only High LD		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
33	CT - METC			1		4	3		3	1	
57	CT - ITC			2	5	2	3	6	2	4	4
3	CT - ATC2							2			
0	CC - METC										
0	CC - ITC										
0	CC - ATC2										
0	COAL - METC										
0	COAL - ITC										
0	COAL - ATC2										
0	CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC	1		3	2	3	3	1	5	1	2
CT - ITC	3	4	3	3	1	3	6	1	4	1
CT - ATC2				1						
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC										
COAL - ITC										
COAL - ATC2										
CFB - ATC2										



# Combustion Turbines Only Scenario Low Load Growth Sensitivity Overview

SIEMENS

- Combustion Turbines Only
- Plan Specifics
  - Low Load Growth
- Alternatives Considered
  - 160 mW CT
- Alternatives Not Considered
  - CC
  - PC
  - CFB
  - IGCC
  - IGCC – PRB coal
  - Nuclear

# Combustion Turbines Only Scenario Low Load Growth Sensitivity Expansion Plan Results

SIEMENS

■ 2006 to 2015

■ Capacity Additions

■ CT	320 mW
■ CC	0 mW
■ PC	0 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	0 mW
■ Total	320 mW

■ Demand Growth 0.21 %

■ Reserve Margin 15.96 %

■ Plan Costs

■ NPV Utility Cost	\$28,856.0 M
■ NPV Emissions	\$ 3,354.0 M
■ NPV CO2	\$ 0.0 M

■ 2006 to 2025

■ Capacity Additions

■ CT	7,680 mW
■ CC	0 mW
■ PC	0 mW
■ Nuclear	0 mW
■ Renewable	0 mW
■ Energy Efficiency	0 mW
■ Total	7,680 mW

■ Demand Growth 0.76 %

■ Reserve Margin 16.09 %

■ Plan Costs

■ NPV Utility Cost	\$50,737.5 M
■ NPV Emissions	\$ 5,308.7 M
■ NPV CO2	\$ 0.0 M

# Combustion Turbines Only Scenario Low Load Growth Sensitivity Expansion Plan Schedule

SIEMENS

CT Only Low LD		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
13	CT - METC										
33	CT - ITC										1
2	CT - ATC2							1			
0	CC - METC										
0	CC - ITC										
0	CC - ATC2										
0	COAL - METC										
0	COAL - ITC										
0	COAL - ATC2										
0	CFB - ATC2										

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
CT - METC	1	2	1	1	2	1	2	1		2
CT - ITC	2	2	4	3	2	4	5	4	4	2
CT - ATC2										1
CC - METC										
CC - ITC										
CC - ATC2										
COAL - METC										
COAL - ITC										
COAL - ATC2										
CFB - ATC2										



# Summary Across Expansion Plans: 2006-2015

**SIEMENS**

Plan Name	Total Capacity Added mW	CT Capacity mW	CC Capacity mW	PC Capacity mW	Nuclear Capacity mW	Renewable Capacity mW	Energy Efficiency mW	Ending Reserve Margin %	Ending Peak Demand mW	PVRR \$M
Central Station	3,440	1,440	0	2,000	0	0	0	15.26%	26,371	\$32,073.0
CS High Load	6,740	2,240	1,500	3,000	0	0	0	15.26%	29,008	\$35,512.2
CS Low Load	660	160	0	500	0	0	0	17.28%	23,458	\$28,873.2
CS Reduce Import	3,440	1,440	0	2,000	0	0	0	15.26%	26,371	\$32,169.2
CS Expanded Trans	2,660	160	500	2,000	0	0	0	12.53%	26,371	\$32,329.1
Emissions	3,440	1,440	500	1,500	0	0	0	15.26%	26,371	\$36,956.6
Emissions High Load	6,760	1,760	2,000	3,000	0	0	0	15.33%	29,008	\$40,832.7
Emissions Low Load	320	320	0	0	0	0	0	15.96%	23,458	\$33,321.8
Emissions Renew & EE	3,026	320	0	500	0	599	1,609	16.25%	24,177	\$36,203.2
Emissions EE Only	3,249	640	0	1,000	0	0	1,609	16.09%	24,177	\$36,189.0
Renewable Generation	3,37	1,280	0	1,500	0	599	0	15.97%	26,371	\$32,612.1
Renewable High Load	6,699	1,600	1,500	3,000	0	599	0	15.98%	29,008	\$36,034.6
Renewable Low Load	599	0	0	0	0	599	0	18.07%	23,458	\$29,541.5
Energy Efficiency	3,249	640	0	1,000	0	0	1,609	16.09%	24,177	\$31,510.1
EE High Load	6,569	960	1,500	2,500	0	0	1,609	16.08%	26,752	\$34,918.3
EE Low Load	1,609	0	0	0	0	0	1,609	23.11%	21,600	\$28,638.7
EE Reduce Pen	3,267	640	0	1,500	0	0	1,127	15.69%	24,648	\$32,208.7
EE & Renew	3,028	320	0	500	0	599	1,609	16.25%	24,177	\$32,103.3
EE&R High Load	6,188	480	1,500	2,000	0	599	1,609	15.69%	26,752	\$35,459.6
EE&R Low Load	2,208	0	0	0	0	599	1,609	26.70%	21,600	\$29,351.7
EE&R Reduce Penetration	3,386	160	0	1,500	0	599	1,127	17.10%	24,648	\$32,797.3
CTs Only	3,520	3,520	0	0	0	0	0	15.54%	26,371	\$32,126.9
CTs Only High Load	6,720	6,720	0	0	0	0	0	15.20%	29,008	\$35,630.2
CTs Only Low Load	320	320	0	0	0	0	0	15.96%	23,458	\$28,856.0



# Summary Across Expansion Plans: 2006-2025

SIEMENS

Plan Name	Total Capacity Added mW	CT Capacity mW	CC Capacity mW	PC Capacity mW	Nuclear Capacity mW	Renewable Capacity mW	Energy Efficiency mW	Ending Reserve Margin %	Ending Peak Demand mW	PVRR \$M
Central Station	11,260	1,760	500	9,000	0	0	0	15.52%	29,856	\$56,716.9
CS High Load	15,040	3,040	2,000	10,000	0	0	0	15.63%	32,841	\$64,116.8
CS Low Load	7,640	640	500	6,500	0	0	0	15.95%	26,870	\$49,811.6
CS Reduce Import	11,220	2,720	1,000	7,500	0	0	0	15.40%	29,856	\$57,004.8
CS Expanded Trans	10,300	800	1,000	8,500	0	0	0	12.56%	29,856	\$57,085.5
Emissions	10,760	1,760	1,000	2,000	6,000	0	0	16.04%	29,856	\$70,752.2
Emissions High Load	14,240	2,240	2,000	4,000	6,000	0	0	15.26%	32,841	\$79,492.7
Emissions Low Load	7,480	480	0	1,000	6,000	0	0	17.69%	26,870	\$62,254.7
Emissions Renew & EE	10,079	480	500	500	5,000	798	2,801	16.89%	26,404	\$66,179.2
Emissions EE Only	11,261	960	0	1,500	5,000	0	2,801	16.53%	26,404	\$66,707.5
Renewable Generation	11,218	1,920	500	8,000	0	798	0	16.28%	29,856	\$58,081.4
Renewable High Load	14,698	2,400	2,000	9,500	0	798	0	15.48%	32,841	\$65,343.3
Renewable Low Load	7,238	1,440	0	5,000	0	798	0	15.55%	26,870	\$51,382.5
Energy Efficiency	10,581	1,280	0	6,500	0	0	2,801	15.73%	26,404	\$53,794.5
EE High Load	14,241	1,440	2,000	8,000	0	0	2,801	15.45%	29,320	\$61,040.0
EE Low Load	6,781	480	0	3,500	0	0	2,801	15.53%	23,488	\$47,384.1
EE Reduce Pen	10,700	1,280	0	7,500	0	0	1,920	15.36%	27,269	\$55,765.2
EE & Renew	10,359	1,760	0	5,000	0	798	2,801	15.95%	26,404	\$55,207.9
EE&R High Load	13,899	800	2,000	7,500	0	798	2,801	15.28%	29,320	\$62,365.1
EE&R Low Load	6,579	480	0	2,500	0	798	2,801	15.86%	23,488	\$48,992.6
EE&R Reduce Penetration	10,518	800	500	6,500	0	798	1,920	15.70%	27,269	\$57,130.8
CTs Only	11,200	11,200	0	0	0	0	0	15.34%	29,856	\$58,987.6
CTs Only High Load	14,880	14,880	0	0	0	0	0	15.18%	32,841	\$68,096.6
CTs Only Low Load	7,680	7,680	0	0	0	0	0	16.09%	26,870	\$50,737.5

