Appendix E

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Integrated Resource Plan Engineering Study Technical Assessment

Prepared for
NIPSCO

Report SL-012949

Project 12749-842
November 2015

NIPSCO

F I N A L

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Integrated Resource Plan Engineering Study
Technical Assessment

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NIPSCO
Integrated Resource Plan Engineering Study
Technical Assessment

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ACRONYMS AND ABBREVIATIONS

Term	Definition or Clarification
ACI	Activated Carbon Injection
AFUDC	Allowance for Funds Used During Construction
AMSL	Above mean sea level
APWR	Advanced pressurized water reactor
ASU	Air separator unit
BACT	Best available control technology
BLS	Bureau of Labor Statistics
BOP	Balance of plant
C&I	Commercial and industrial
CAA	Clean Air Act
CAES	Compressed air energy storage
CC	Combined cycle
CCHP	Combined Cooling, Heat and Power
CCS	Carbon capture and sequestration
CHP	Combined heat and power
CO	Carbon monoxide
CSP	Concentrated solar power
CT	Combustion turbine
CTG	Combustion turbine generator
CWA	Clean Water Act
DBB	Design-Bid-Build
DG	Distributed generation
DLN	Dry-low NOx combustion
DOE	Department of Energy
DSI	Dry sorbent injection
DSIRE	Database of State Incentives for Renewables & Efficiency®
EAF	Equivalent availability factor
EFOR	Equivalent forced outage rate
EGU	Electric generating unit

ACRONYMS AND ABBREVIATIONS (cont.)

Term	Definition or Clarification
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EPC	Engineer, procure, and construct
EPRI	Electric Power Research Institute
ERC	Emission reduction credits
ESP	Electrostatic precipitator
FERC	Federal Energy Regulatory Commission
FF	Fabric filter
FGD	Flue gas desulfurization
FICA	Federal Insurance Contributions Act
FIT	Feed-in tariff
FOH	Forced outage hours
FPM	Filterable particulate matter
GE	General Electric
GHG	Greenhouse gas
HAP	Hazardous air pollutant
HCl	Hydrogen chloride
Hg	Mercury
HHV	Higher heating value
hp	Horsepower
HRSG	Heat recovery steam generator
HVAC	Heating, Ventilation, & Air Conditioning
Hz	Hertz
IAC	Indiana Administrative Code
ICI	Industrial-Commercial-Institutional
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IGCC	Integrated gasification combined cycle
IRP	Integrated resource plan

ACRONYMS AND ABBREVIATIONS (cont.)

Term	Definition or Clarification
kW	kilowatt
LAER	Lowest achievable emissions rate
LAES	Liquefied air energy storage
LNB	Low NO_x burners
MACT	Maximum Achievable Control Technology
MATS	Mercury and Air Toxics Standards
MGD	Million gallons per day
mmBtu	Millions of Btu
MW	Megawatt
MWh	Megawatt-hour
MYRD&D	Multi-Year Research, Development, and Demonstration
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NNSR	Non-attainment New Source Review
NOWS	National Offshore Wind Strategy
NO_X	Nitric oxide (NO) and nitrogen dioxide (NO_2)
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NREL	National Renewable Energy Laboratory
NSCR	Non-selective catalytic reduction
NSPS	New Source Performance Standards
NSR	New Source Review
O&M	Operation and maintenance
O_2	Oxygen
OFA	Overfire air
OSWInD	Offshore Wind Innovation and Demonstration Initiative
PAS	Personnel Administration Services
Pb	Lead
PC	Pulverized coal

ACRONYMS AND ABBREVIATIONS (cont.)

Term	Definition or Clarification
PCB	Polychlorinated biphenyls
PH	Period hours
PILOT	Payments in lieu of taxes
PJFF	Pulse jet fabric filter
PM	Particulate matter
PM_{10}	Particulate matter less than 10 micrometers
$PM_{2.5}$	Particulate matter less than 2.5 micrometers
ppbvd	Parts per billion volume dry
ppmvd	Parts per million volume dry
PSD	Prevention of Significant Deterioration
PV	Photovoltaic
R&D	Research and development
RBLC	RACT/BACT/LAER Clearinghouse
RFP	Request for proposal
RH	Relative Humidity
rpm	Revolutions per minute
S&L	Sargent & Lundy LLC
SCR	Selective catalytic reduction
SGC	Syngas cleanup
SHP	Separate Heat and Power
SIP	State Implementation Plan
SMR	Small modular reactor
SNCR	Selective non-catalytic reduction
SO_2	Sulfur dioxide
SOH	Schedule outage hours
SPRINT	Spray inter-cooled
ST	Steam turbine
STG	Steam turbine generator
Syngas	Synthesis gas

ACRONYMS AND ABBREVIATIONS (cont.)

Term	Definition or Clarification
T&D	Transmission and distribution
TES	Thermal energy storage
tpy	Tons per year
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VOC	Volatile organic carbon
VOM	Variable O&M
WFGD	Wet Flue gas desulfurization
WTG	Wind-turbine generator

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1. EXECUTIVE SUMMARY

1.1 PROJECT INTRODUCTION

To support development of its 2016 IRP, The Northern Indiana Public Service Company (NIPSCO) engaged Sargent & Lundy LLC (S&L) to conduct a technical assessment of various generation technologies reflective of a Northern Indiana location. The list of technologies considered in the study was discussed during the project kick-off meeting and includes the technical options that might be considered feasible for the NIPSCO service territory and other options that are of interest to the utility, regulators, and stakeholders.

This technology assessment study includes an evaluation of the following technologies:

- Natural Gas Technologies – Section 4
  - Simple Cycle Aeroderivative Combustion Turbine (50 MW)
  - Simple Cycle Frame Combustion Turbine (240 MW)
  - Combined Cycle Frame Combustion Turbines (700 MW)
  - Combined Cycle Bailly Unit 7 Repowering (Coal to Combined Cycle Conversion)
  - Combined Cycle Schahfer 16A/B Conversion (2 Simple Cycle Frames to Combined Cycle)
  - Combined Cycle Generic Conversion (2 Simple Cycle Frames to Combined Cycle)
  - Black Start Retrofit at Schahfer Unit 16B
  - Coal to Natural Gas Boiler Conversion at Schahfer Unit 14
  - Coal to Natural Gas Boiler Conversion at Schahfer Unit 15
  - Coal to Natural Gas Boiler Conversion at Schahfer Unit 17 and 18
  - Coal to Natural Gas Boiler Conversion at Schahfer Unit 14, 15, 17, and 18 Collectively
- Coal and Nuclear Technologies – Section 5
  - Supercritical Pulverized Coal (750 MW gross)
  - Circulating Fluidized Bed Coal with Fuel Flexibility (400 MW gross)
  - Integrated Gasification Combined Cycle (600 MW gross)
  - Advanced Pressurized Water Reactor (2200 MW)
  - Small Modular Reactor (45 MW)
- Renewable Technologies – Section 6
  - Bubbling Fluidized Bed Biomass Boiler (50 MW)
  - Onshore Wind (100 MW)
  - Offshore Wind (50 MW)

  - Concentrated Solar Power (50 MW)
  - Utility Scale Solar Photovoltaic (50 MW)
  - Geothermal (5 MW)
- Energy Storage Technologies – Section 7
  - Pumped Storage
  - Thermal Storage
  - Compressed Air Storage
  - Liquefied Air Storage
  - Battery Storage
- Distributed Generation Technologies – Section 8
  - Reciprocating Engine Firing Biogas and/or Conventional Fuel Supply
  - Microturbines
  - Fuel Cells
  - Distributed Solar PV
  - Distributed Wind
  - Combined Heat and Power
  - Microgrids
- Grid Reliability Enhancements – Section 9
  - Interconnection Upgrades for Distributed Generation
  - Volt/VAR Optimization and Sensors

The assessment includes a review of the environmental requirements that apply to each generating technology to identify specific emission control technologies, for which cost, performance, and emissions data was developed. For the conventional technologies (i.e. natural gas, coal, and nuclear), the types of alternatives are well-known, and therefore, NIPSCO identified the specific configurations to consider. For renewable energy, energy storage, and distributed generation, a more extensive distributed generation screening analysis was performed to identify the commercially available technologies and the emerging technologies seen throughout the power industry. The complete distributed generation screening analysis is attached to this report as Appendix A. Throughout the remainder of this report, S&L presents the estimated cost, performance, and emissions data for both the conventional technologies and selected distributed generation technologies as well as the methodology and assumptions underlying these estimates.