NREL
NATIONAL RENEWABLE ENERGY LABORATORY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Navajo Generation Station – NREL Phase 2 Study

Northern Arizona University

Tribal Solar Working Group




Kevin Black, Sr.
Program Manager
Energy Development
Bureau of Reclamation
Phoenix Area Office

Agenda

- Navajo Generating Station
  - Background
  - Proposed Action – Purpose and Need
  - Environmental Impact Statement
- National Renewable Energy Lab (NREL) Phase II Study
  - Stakeholder Outreach
  - Scope of Work
  - Baseline
  - Glidepaths
  - Milestones and Final Report
- Questions

Navajo Generating Station Programs (NGSP)

Russ Callejo
General NEPA, ESA, NHPA Compliance

General Environmental Matters

Navajo Generating Station – Kayenta Mine Complex Environmental Impact Statement

Programmatic Agreement

Biological Assessment

Tribal Consultations

Los Angeles Department of Water & Power Divestiture Environmental Compliance

Nevada Energy Divestiture Environmental Compliance

Kevin Black
Program Manager
Energy Development

Joint Federal Agency Working Group Coordination

- Tribal Clean Energy Development
- NREL II Study

Technical Working Group Agreement

- Implementation
  - Appendix "C"
  - Qualifying Projects Catalog
  - NGS Roadmap & Glidepath Development

NGSP Coordination

- NGS Environmental Program
- Operation & Maintenance

Ron Smith
General Engineering & Operating Committee Responsibilities – Generation & Transmission

Lease Amendment & Coal Supply Agreement Negotiations

Los Angeles Department of Water & Power Divestiture

Nevada Energy Divestiture

Technical Working Group Appendix C Implementation Technical Support

NGS-KMC EIS Technical Support

General Technical Support

Coordination | Collaboration | Communication | Cooperation

Environmental Program

Energy Development Program

Operations & Maint. Program

NGS Background

- 2,250 MW coal-fired power plant on lands leased from the Navajo Nation near Page, AZ
- Congress authorized construction of the CAP in 1968, including federal participation in the NGS
- Federal share in NGS is 547 MW
  - ~360 MW for CAP pumping
  - ~187 MW for surplus
- Federal NGS power surplus to CAP load is sold at market rates; revenues assist in CAP repayment and Indian water settlements under Arizona Water Settlement Act
- Coal used by the NGS is exclusively supplied by the Kayenta Mine, located on lands leased from the Navajo Nation and Hopi Tribe

RECLAMATION

NGS Proposed Action

- NGS lease and right of way grants begin to expire in December 2019; significant permit revision application for Kayenta Mine under review by OSMRE

- Proposed Action: Obtain necessary Federal approvals to continue the NGS and Kayenta Mine from 2020 through 2044

- Purpose and Need (P&N) for Reclamation: Secure, after 2019, a cost-effective reliable source of power and energy that would be continuously available to operate the CAP, and generate surplus revenues

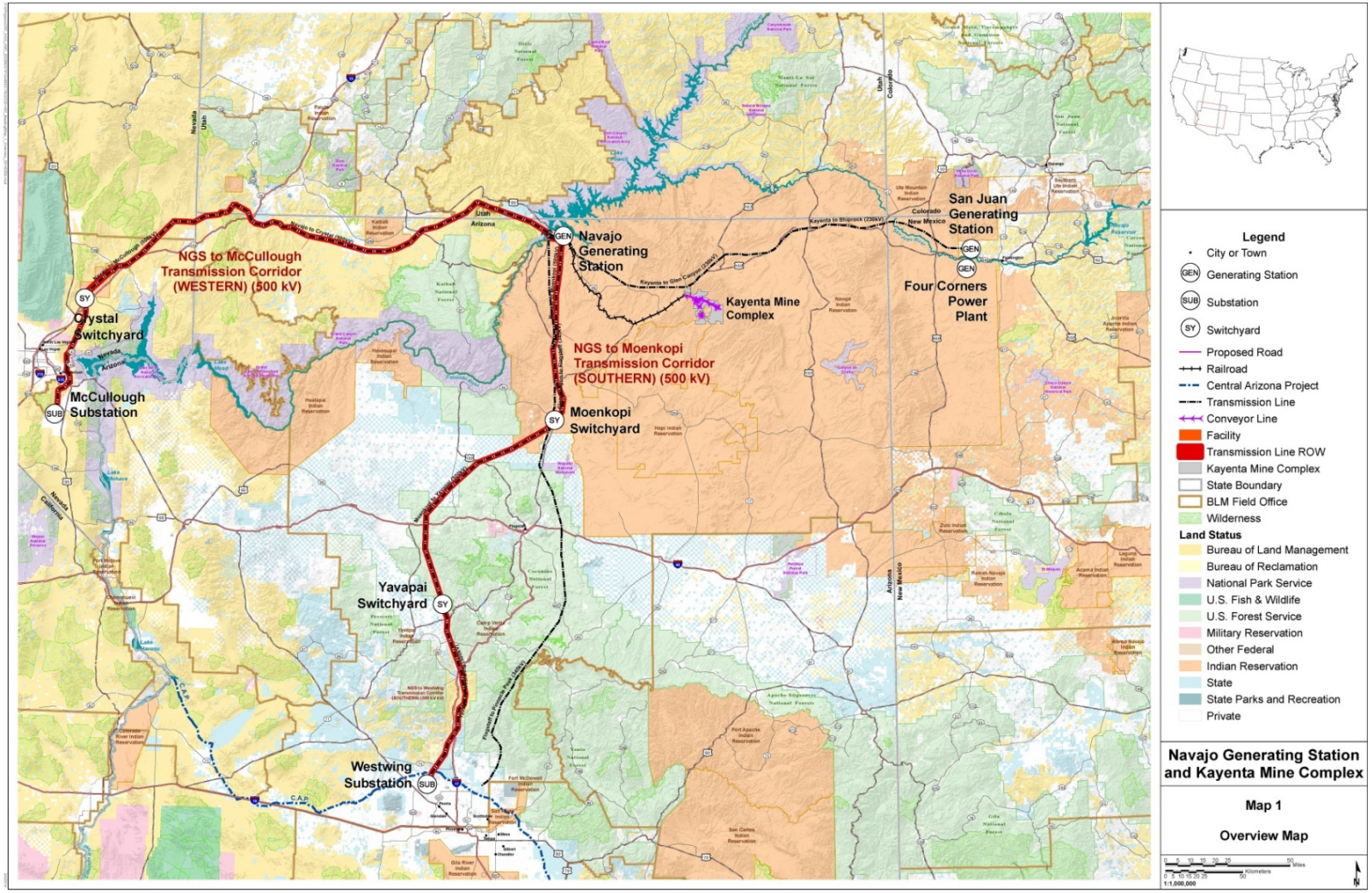
- Any action alternatives considered must meet the P&N

- Notice of Intent (NOI) to prepare a single Environmental Impact Statement (EIS) was published in May 2014.

Federal Actions

- Approval of Plant Site Lease Amendment (BIA)
- Issuance of Grants of ROW and Easements for Plant, Railroad, and Transmission Lines on Navajo Reservation (BIA)
- Conversion of Revocable/Special Use Permits to §323/§169 Grants of ROW (BIA)
- Issuance of Southern and Western Transmission ROWs off Navajo Reservation (BLM, USFS)
- Issuance of ROW for Water Intake off Navajo Reservation (NPS)
- Water Service Contract Renewal through 2044 (Reclamation)
- Kayenta Mine Permit Revision for mining post-2019 (OSMRE)
- Coal Supply Agreement post-2019 (Reclamation)

EIS General Project Area



RECLAMATION

EIS Target Milestones

We are here

RECLAMATION

Reclamation/Dept. of Energy Interagency Agreement

- Technical Assistance
  - Clean Energy Development Planning
  - NGS KMC EIS
  - NREL II Study

Joint Statement by DOI, DOE, EPA (2013)

- Long-term goals
  - Clean, affordable and reliable power
  - Affordable and sustainable water supplies
  - Sustainable economic development
  - Minimize negative impacts on those who currently obtain significant benefits from NGS
- Complete NREL Phase 2 report to formulate and analyze clean energy alternatives to NGS
- NREL Phase 2 Study to inform NGS Road Map

NREL PHASE ONE STUDY

NREL Phase 1 (Jan. 2012)

- Driven by EPA notice of intent to issue BART rule for NGS
- Examined NGS history, operation characteristics, role in CAP rates, role in water settlement
- Provided initial analytical benchmarks based on cost of NO_x mitigation

NREL Phase 1 supplement (April 2012)

- Characterization of renewable resource potential that could contribute to an NGS replacement portfolio

Technical Working Group Agreement

- Proposed “better-than-BART” alternative for reducing NO_x emissions
- Additional federal commitments
  - Clean energy
  - Carbon reduction
- Proposed framework for NREL Phase 2 Study
  - Identified tribal and non-tribal constituencies
  - A study to inform a NGS Roadmap

NREL Phase 2 Study

- Stakeholder Outreach & Study Scope
- Baseline analysis
  - How is the Southwest electricity sector changing independent of what might happen with NGS?
  - Rationale: current costs are not a valid standard for evaluating any NGS future
- Formulation and Analysis of glidepath options
  - “Appraisal level” rather than project-specific
  - Knowledge base for federal decision support

Phase 2 Study: Baseline

Baseline

Sectoral trends

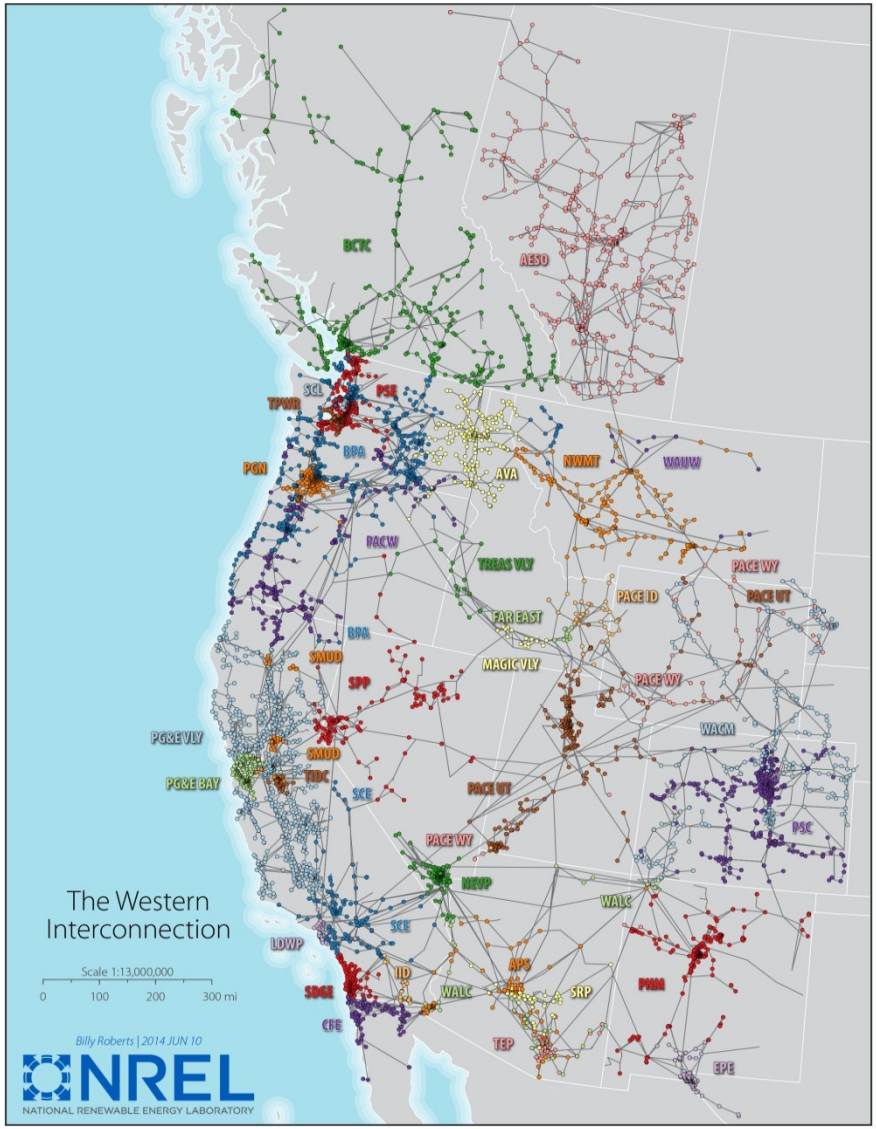
Technology costs, policy environment, and operational advances; how utilities are responding (IRPs)

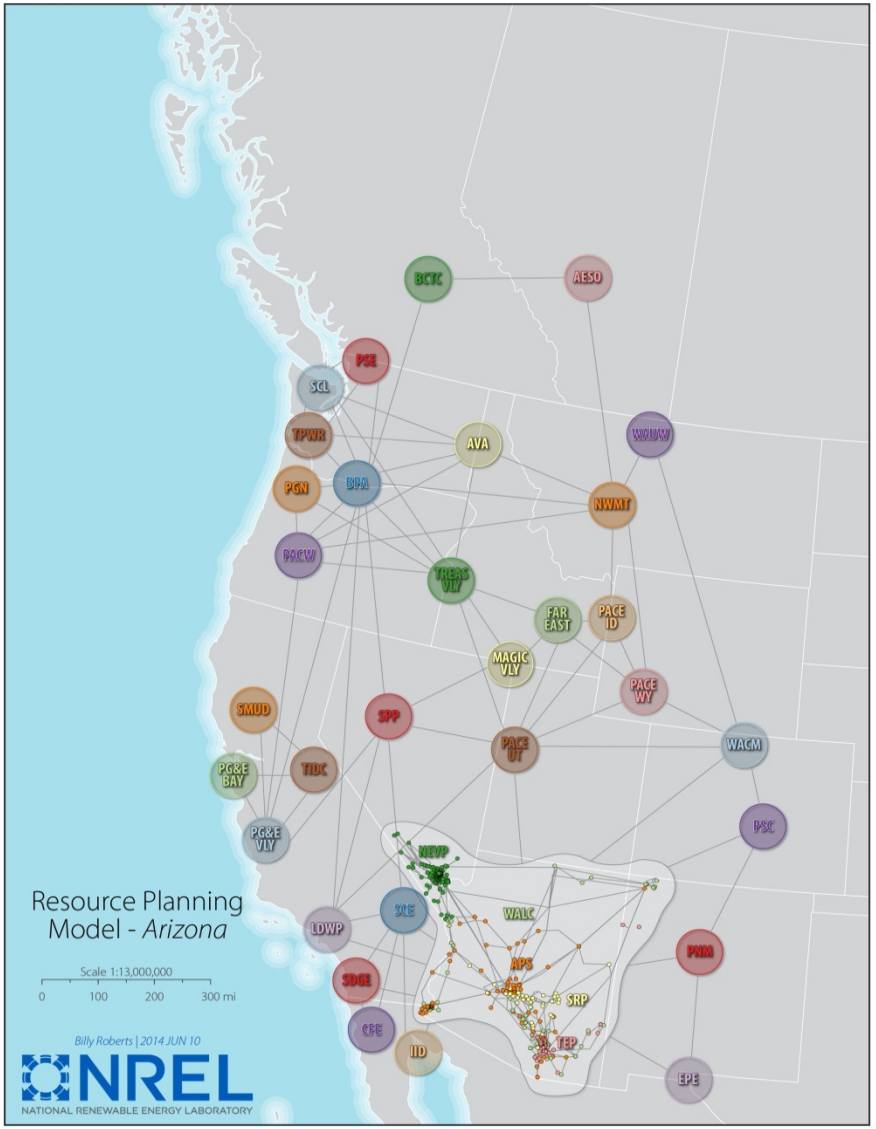
Technical modeling

Quantify the likely changes in new capital investment (fixed costs) and production costs (variable costs) for electricity

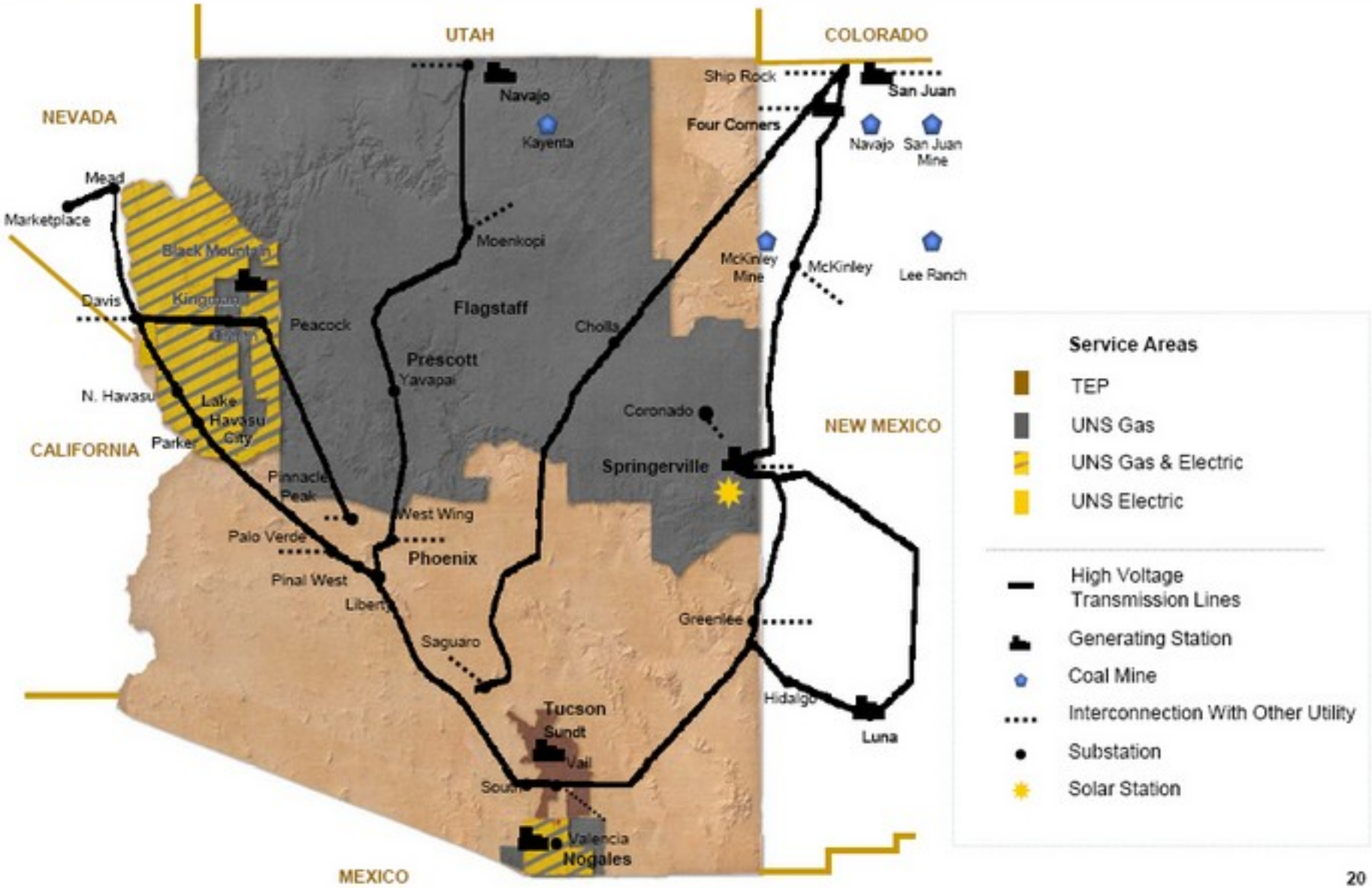
Economic modeling

Forecast how current sector-wide fixed cost and variable cost trends will affect the Arizona economy


BCTC
AESO
SCL
PSE
TPWR
BPA
PGN
AVA
NWMT
WAUW
PACW
TREAS VLY
PACE WY
PACE ID
PACE UT
FAR EAST
BPA
SMUD
SPP
MAGIC VLY
PACE WY
PG&E VLY
WACM
SMUD
PG&E BAY
TIDC
SCE
PACE UT
PSC
PACE WY
NEVP
WALC
SCE
LDWP
APS
ID
SDGE
WALC
SRP
PNM
CFE
TEP
EPE
The Western Interconnection
Scale 1:13,000,000
0 100 200 300 mi
Billy Roberts | 2014 JUN 10
NREL
NATIONAL RENEWABLE ENERGY LABORATORY


BCTC
AESO
PSE
SCL
TPWR
AVA
WAUW
PGN
BPA
NWMT
PACW
TREAS VLY
FAR EAST
PACE ID
MAGIC VLY
PACE WY
SMUD
SPP
PACE UT
WACM
PG&E BAY
TIDC
PSC
PG&E VLY
NEVP
SCE
WALC
LDWP
APS
PNM
SDGE
SRP
CFE
TEP
ID
EPE
Resource Planning Model - Arizona
Scale 1:13,000,000
0 100 200 300 mi
Billy Roberts | 2014 JUN 10
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Utility Service Areas



What is a "Glidepath"?

- **Multi-component strategy for transitioning federal interest in NGS to clean, low-emitting energy sources**
  - Tests selection and timing of new technologies
    - NOT selection of specific projects within a technology category
  - Allows for some transitional operation of NGS, provided the glidepath achieves the federal goals
- **Does not preclude operating NGS without federal participation**
- **Analysis of possible actions**

Phase 2 Study: Glidepath Options

Glidepath options

Utility-scale clean energy strategies

Appraise technically feasible options for providing CAP electricity, appraise impacts relative to baseline

Expansion Capability

Appraise the feasibility of upsizing the utility-scale options to provide surplus power

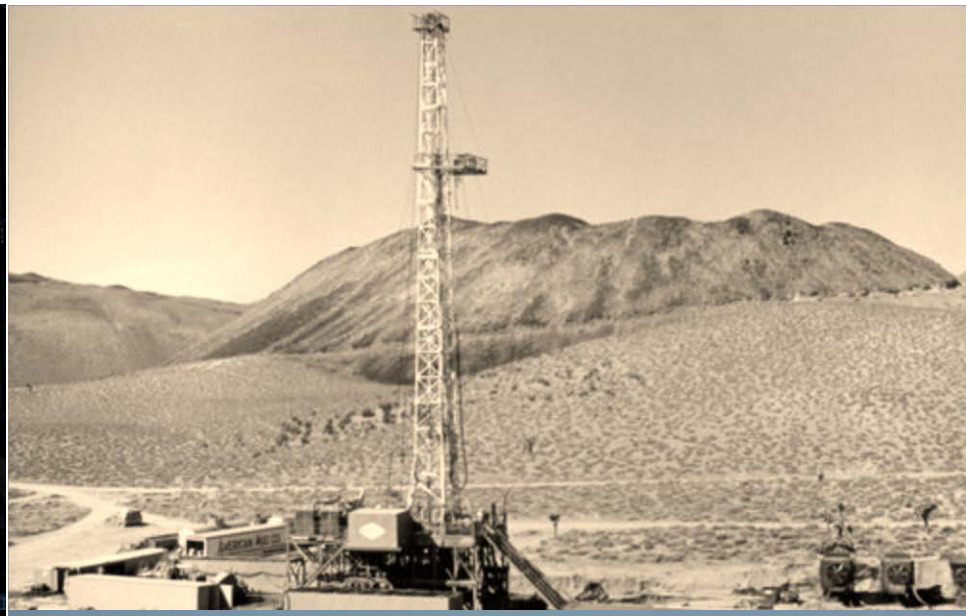
Impacts on NGS Constituencies

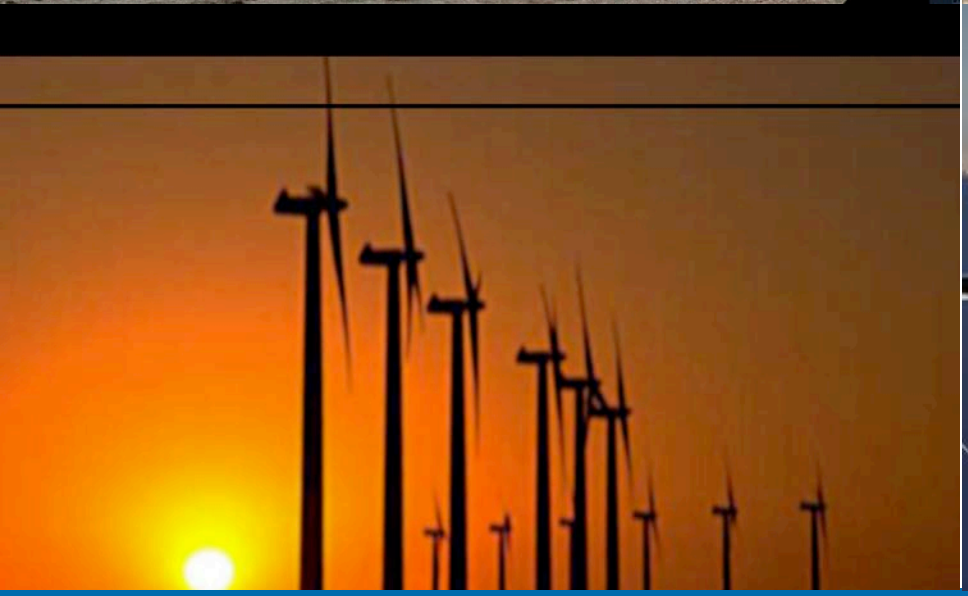
Evaluate the economic impacts of glidepath options; appraise local projects that could reduce disruptive effects

Several Glidepath Analyses

- **Questions for each glidepath analysis**
  - How will cost of component technologies change over time, and at what point might the technology become economically competitive?
  - How effectively does the glidepath portfolio contribute to federal goals?
  - What types of federal participation might make a glidepath more feasible or competitive?

Portfolio Diversity

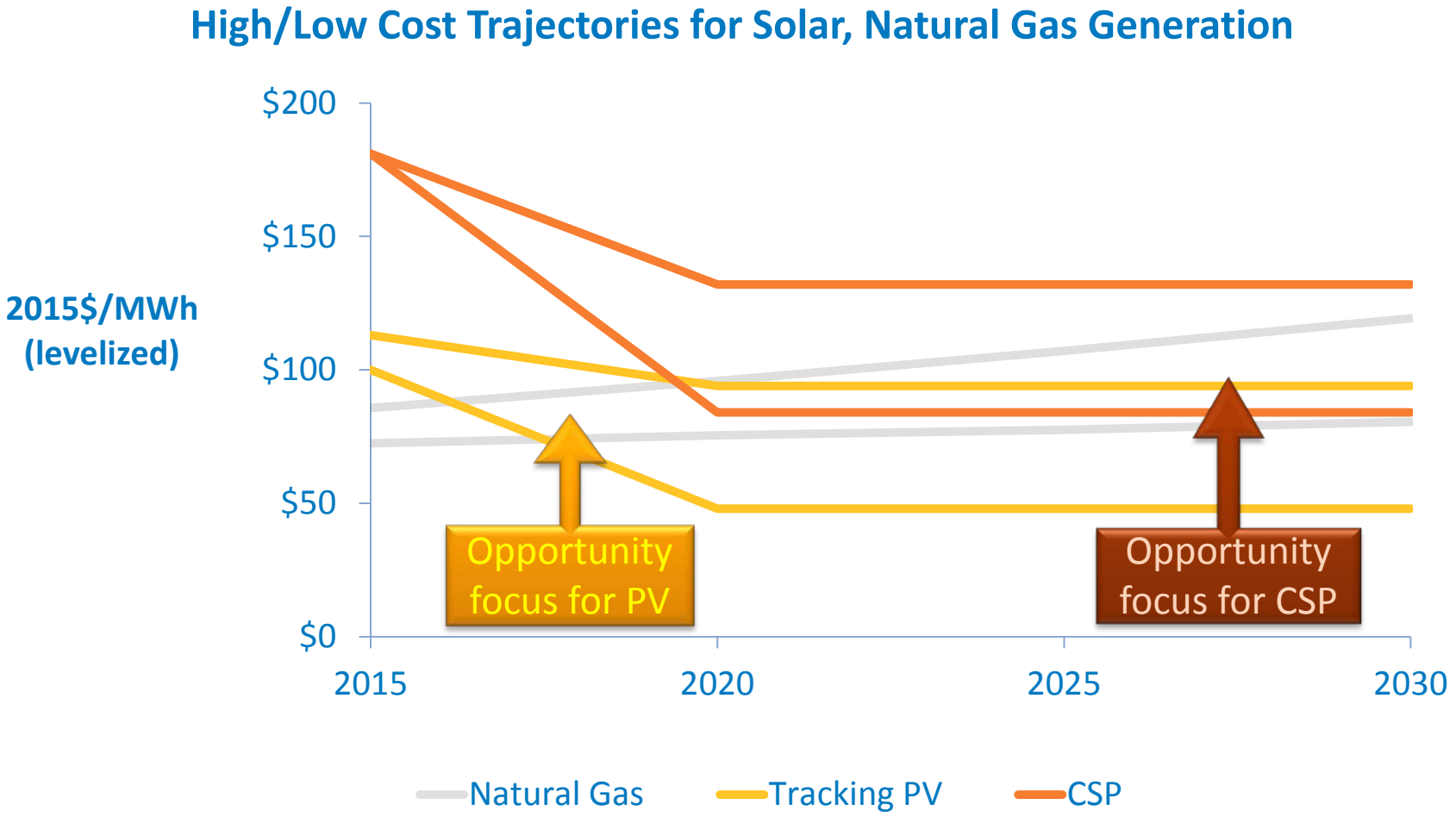




Technology Components

- **Different combinations of**
  - Utility-scale PV near CAP transmission
  - Geothermal
  - Wind power
  - Concentrating solar power (CSP)
  - CSP thermal augmentation of an existing NGS unit
  - Natural gas

Time Factor: Changes in Technology Costs



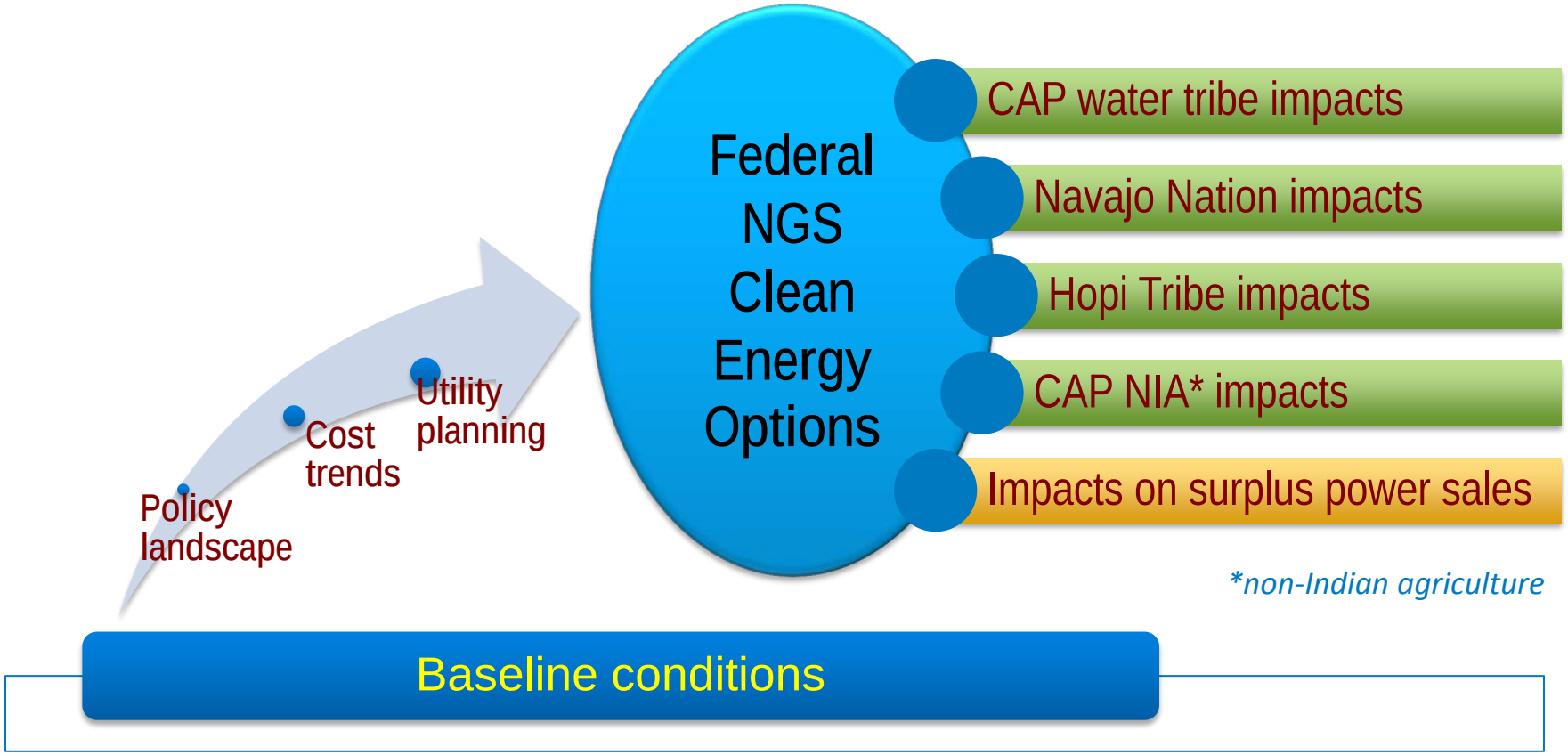
Scope and Attributes

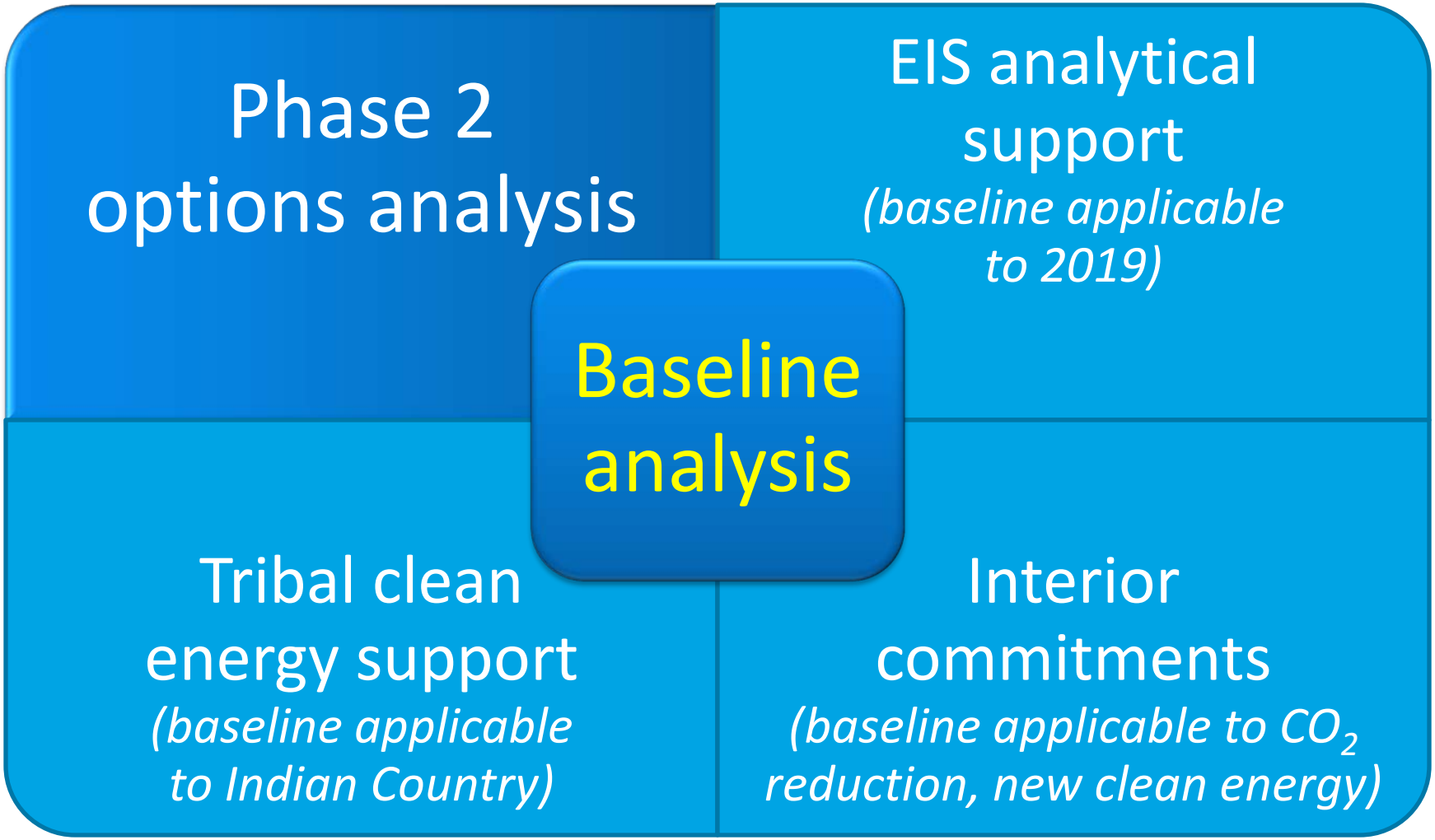
- **Glidepath must comprise enough utility-scale projects to provide power to Central Arizona Project (CAP)**
  - Frames a glidepath's size and focuses the analysis
  - Assumption: CAWCD may but need not select glidepath resources for CAP power
- **Must be economically competitive**
  - If not competitive for CAP, won't be competitive elsewhere
- **Investigate potential of up-sizing to provide surplus energy**

Local Development

- **Glidepath analysis will also appraise local energy-related strategies to minimize negative impacts and promote sustainable economic development for NGS Affected Tribes such as**
  - Energy projects to improve local water delivery
  - Distributed solar
  - Upsizing utility-scale project to provide power for local tribal use

Elements of NGS Phase 2 Study



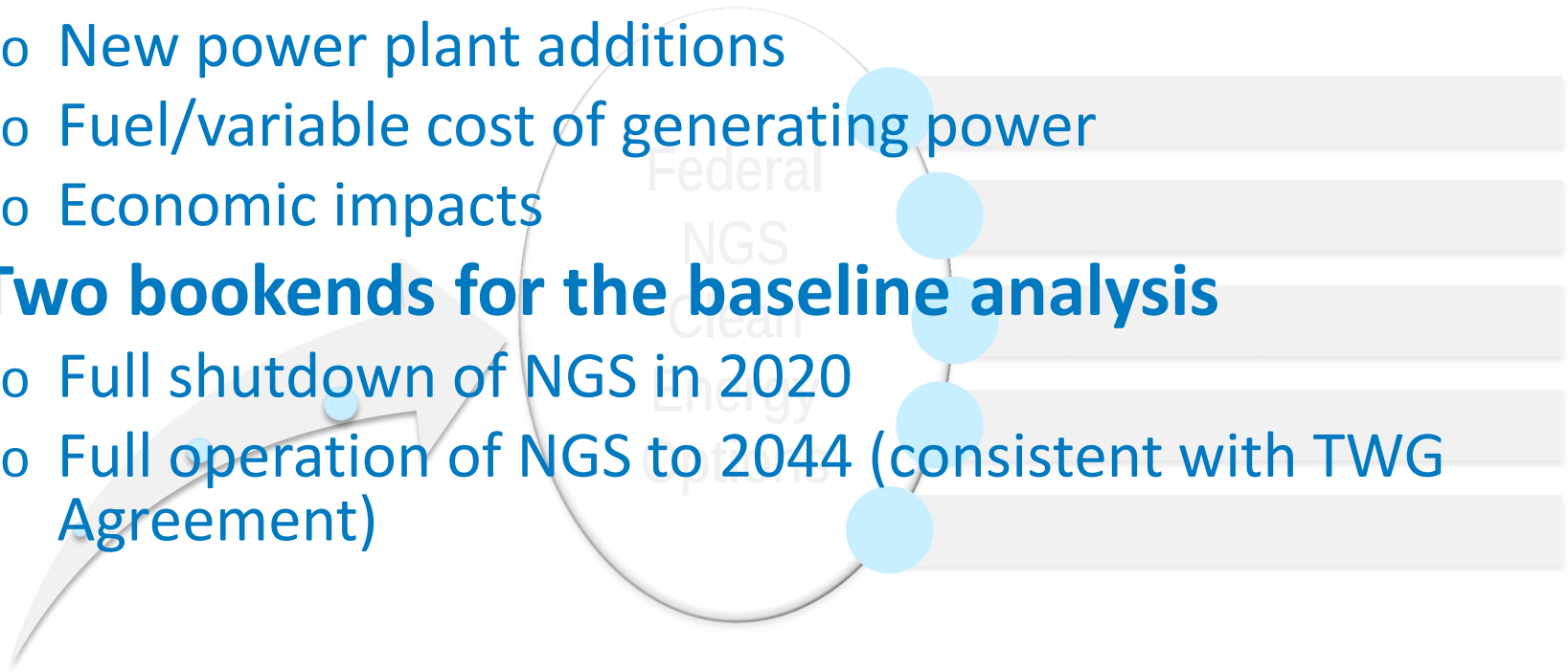

Phase 2 options analysis
EIS analytical support (baseline applicable to 2019)
Baseline analysis
Tribal clean energy support (baseline applicable to Indian Country)
Interior commitments (baseline applicable to CO_2 reduction, new clean energy)

NREL 2 Study Tasks

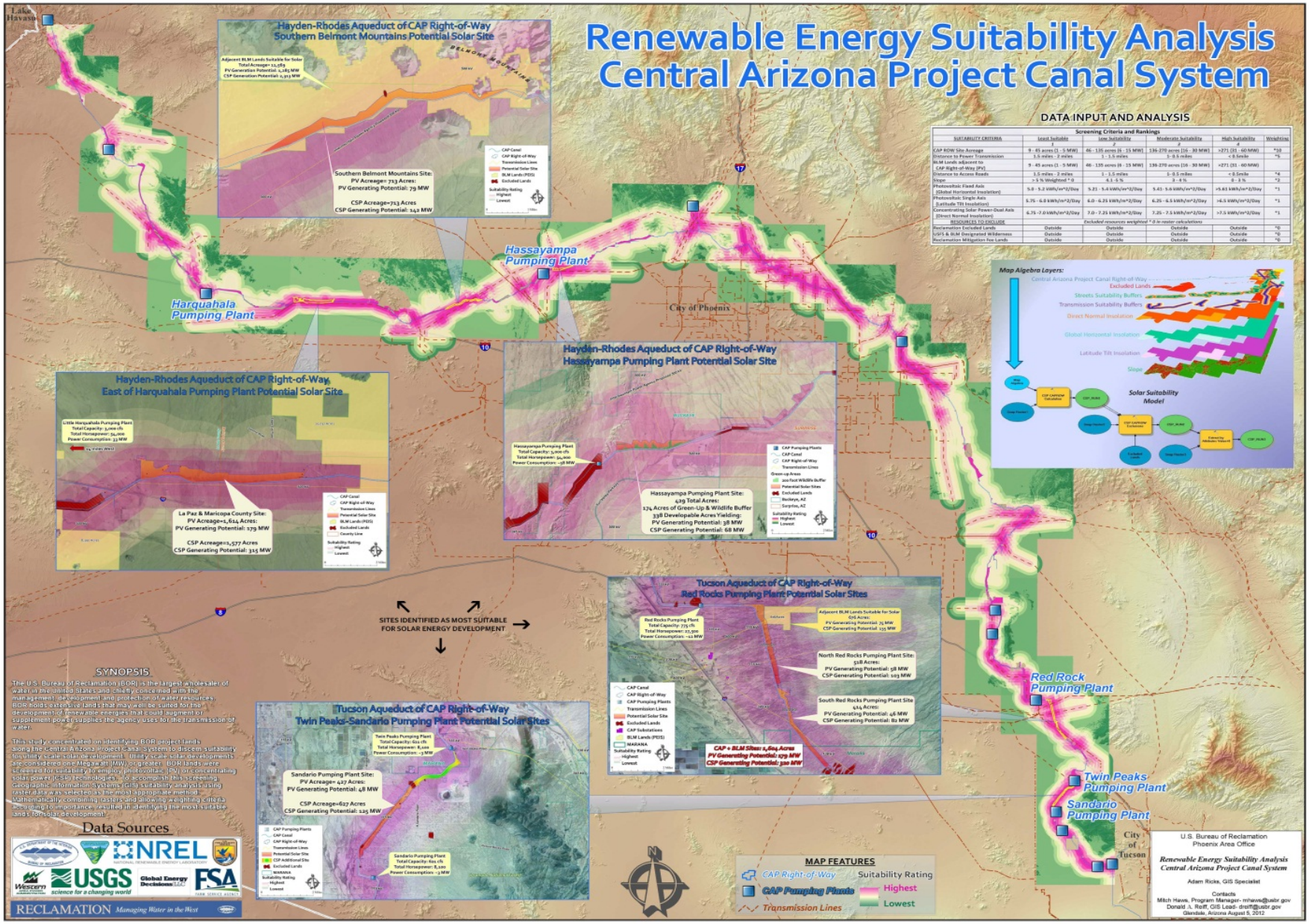
- Task 1 – Baseline Conditions
- Task 2 – Sectoral Trends
- Task 3 – Glidepath Options
- Task 4 – Potential for Surplus Power
- Task 5 – Impacts

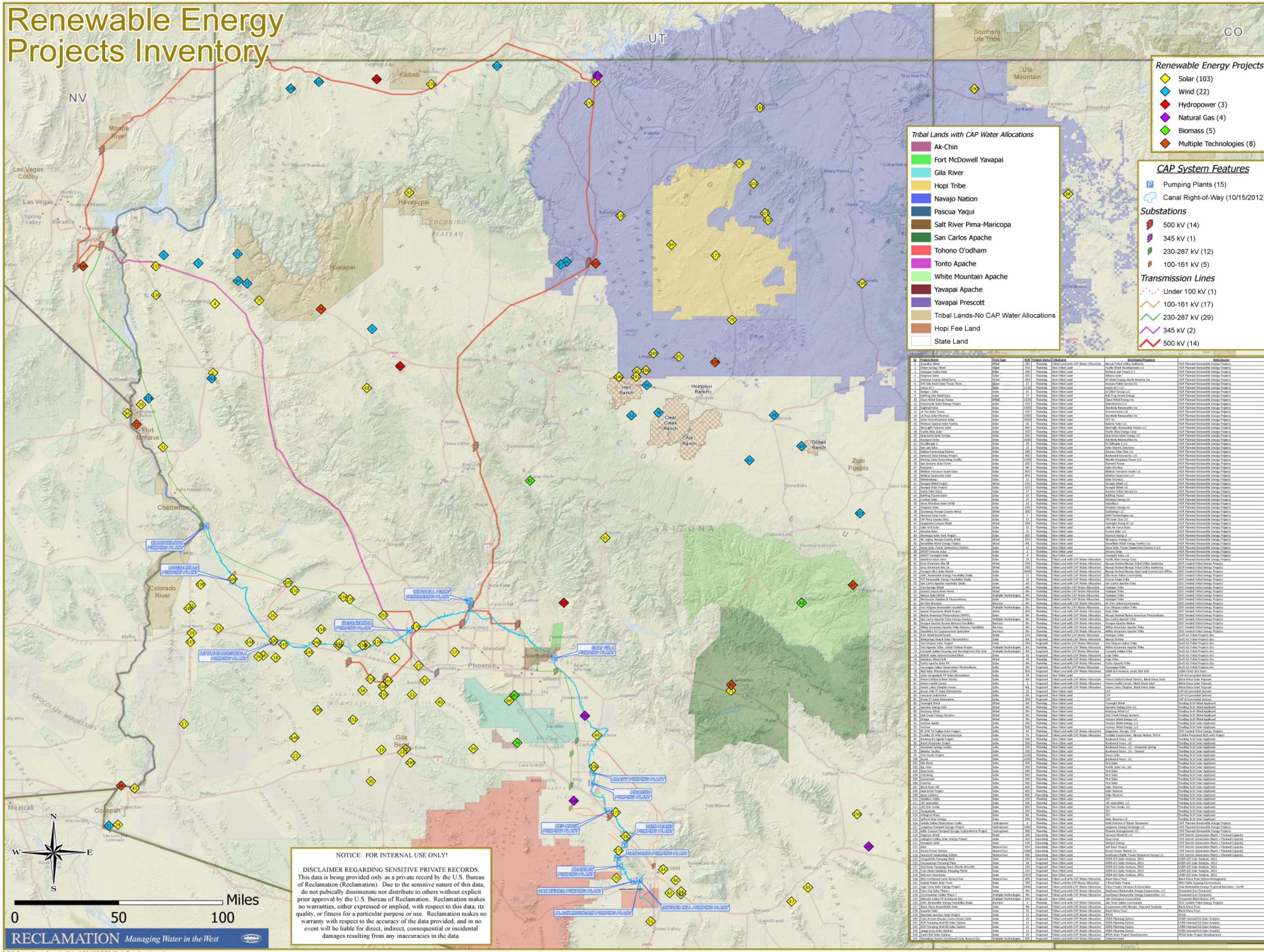
Task 1: Baseline conditions

- **Model current trends with respect to:**
  - New power plant additions
  - Fuel/variable cost of generating power
  - Economic impacts
- **Two bookends for the baseline analysis**
  - Full shutdown of NGS in 2020
  - Full operation of NGS to 2044 (consistent with TWG Agreement)



Baseline conditions


Renewable Energy Suitability Analysis
Central Arizona Project Canal System
Lake Havasu
Hayden-Rhodes Aqueduct of CAP Right-of-Way
Southern Belmont Mountains Potential Solar Site
Southern Belmont Mountains Site:
PV Acreage= 713 Acres:
PV Generating Potential: 79 MW
CSP Acreage=713 Acres
CSP Generating Potential: 143 MW
Hassayampa Pumping Plant
Harquahala Pumping Plant
City of Phoenix
Hayden-Rhodes Aqueduct of CAP Right-of-Way
East of Harquahala Pumping Plant Potential Solar Site
La Paz & Maricopa County Site:
PV Acreage=1,614 Acres:
PV Generating Potential: 179 MW
CSP Acreage=1,577 Acres
CSP Generating Potential: 315 MW
Hayden-Rhodes Aqueduct of CAP Right-of-Way
Hassayampa Pumping Plant Potential Solar Site
Hassayampa Pumping Plant Site:
429 Total Acres:
174 Acres of Green-Up & Wildlife Buffer
338 Developable Acres Yielding:
PV Generating Potential: 38 MW
CSP Generating Potential: 68 MW
DATA INPUT AND ANALYSIS
Screening Criteria and Rankings
Map Algebra Layers:
Central Arizona Project Canal Right-of-Way
Excluded Lands
Streets Suitability Buffers
Transmission Suitability Buffers
Direct Normal Insolation
Global Horizontal Insolation
Latitude Tilt Insolation
Slope
Solar Suitability Model
SITES IDENTIFIED AS MOST SUITABLE FOR SOLAR ENERGY DEVELOPMENT
Tucson Aqueduct of CAP Right-of-Way
Red Rocks Pumping Plant Potential Solar Sites
North Red Rocks Pumping Plant Site:
518 Acres:
PV Generating Potential: 58 MW
CSP Generating Potential: 103 MW
South Red Rocks Pumping Plant Site
414 Acres:
PV Generating Potential: 46 MW
CSP Generating Potential: 82 MW
CAP + BLM Sites: 1,614 Acres
PV Generating Potential: 179 MW
CSP Generating Potential: 320 MW
Red Rock Pumping Plant
Tucson Aqueduct of CAP Right-of-Way
Twin Peaks-Sandario Pumping Plant Potential Solar Sites
Sandario Pumping Plant Site:
PV Acreage= 427 Acres:
PV Generating Potential: 48 MW
CSP Acreage=627 Acres
CSP Generating Potential: 125 MW
Twin Peaks Pumping Plant
Sandario Pumping Plant
City of Tucson
SYNOPSIS
The U.S. Bureau of Reclamation (BOR) is the largest wholesaler of water in the United States and is primarily concerned with the management, development and protection of water resources. BOR holds extensive lands that may well be suited for the development of renewable energy that could augment or supplement power supplies the agency uses for the transmission of water.
This study concentrated on identifying BOR project lands along the Central Arizona Project Canal System to discern suitability for utility scale solar development. Utility scale solar developments are considered one Mega watt (MW) or greater. BOR lands were screened for suitability to employ photovoltaic (PV) or concentrating solar power (CSP) technologies. To accomplish this screening Geographic Information Systems (GIS) suitability analysis using raster data was selected as the most appropriate method. Mathematically combining rasters and allowing weighting criteria to be varied for importance resulted in identifying the most suitable lands for solar development.
Data Sources
NREL
USGS
Western
Global Energy Decisions
FSA
RECLAMATION Managing Water in the West
MAP FEATURES
CAP Right-of-Way
CAP Pumping Plants
Transmission Lines
Suitability Rating
Highest
Lowest
U.S. Bureau of Reclamation
Phoenix Area Office
Renewable Energy Suitability Analysis
Central Arizona Project Canal System
Adam Ricks, GIS Specialist
Contacts
Mitch Hawa, Program Manager- mhawa@usbr.gov
Donald A. Reiff, GIS Lead- dreiff@usbr.gov
Glendale, Arizona August 5, 2012



Renewable Energy Projects Inventory
Renewable Energy Projects
Solar (103)
Wind (22)
Hydropower (3)
Natural Gas (4)
Biomass (5)
Multiple Technologies (8)
CAP System Features
Pumping Plants (15)
Canal Right-of-Way (10/15/2012)
Substations
500 kV (14)
345 kV (1)
230-287 kV (12)
100-161 kV (5)
Transmission Lines
Under 100 kV (1)
100-161 kV (17)
230-287 kV (29)
345 kV (2)
500 kV (14)
Tribal Lands with CAP Water Allocations
Ak-Chin
Fort McDowell Yavapai
Gila River
Hopi Tribe
Navajo Nation
Pascua Yaqui
Salt River Pima-Maricopa
San Carlos Apache
Tohono O'odham
Tonto Apache
White Mountain Apache
Yavapai Apache
Yavapai Prescott
Tribal Lands-No CAP Water Allocations
Hopi Fee Land
State Land
ID | Project Name | Tech Type | MW | Project Status | Tribal Land | Developer/Proposer | Data Source
NOTICE: FOR INTERNAL USE ONLY!
DISCLAIMER REGARDING SENSITIVE PRIVATE RECORDS: This data is being provided only as a private record by the U.S. Bureau of Reclamation (Reclamation). Due to the sensitive nature of this data, do not pubically disseminate nor distribute to others without explicit prior approval by the U.S. Bureau of Reclamation. Reclamation makes no warranties, either expressed or implied, with respect to this data, its quality, or fitness for a particular purpose or use. Reclamation makes no warranty with respect to the accuracy of the data provided, and in no event will be liable for direct, indirect, consequential or incidental damages resulting from any inaccuracies in the data.
Miles
0
50
100
RECLAMATION Managing Water in the West
UT
CO
NV
Phoenix
MARK WILMER PUMPING PLANT
BOUSE HILLS PUMPING PLANT
LITTLE HARQUAHALA PUMPING PLANT
HASSAYAMPA PUMPING PLANT
WADDELL PUMP GENERATING PLANT
SALT GILA PUMPING PLANT
BRADY PUMPING PLANT
PICACHO PUMPING PLANT
RED ROCK PUMPING PLANT
TWIN PEAKS PUMPING PLANT
SANDARIO PUMPING PLANT
BRAWLEY PUMPING PLANT
SAN XAVIER PUMPING PLANT
BLACK MOUNTAIN PUMPING PLANT
SNYDER HILL PUMPING PLANT
P:\GIS_Projects\NavajoGeneratingStation\NGS-KMC EIS\FullPartialProjectInventory.mxd

Low Emitting Technology- Renewable Energy Projects

OBJECTID	Project Name	Tech Type	MW	Development Status	Developer
48	Ecoenergy Navajo County Wind	Wind	300	Planning	EcoEnergy LLC
52	Grapevine Canyon Wind	Wind	500	Planning	Firestight Flying M LLC
60	NZ Legacy Navajo County Wind	Wind	150	Planning	NZLegacy Energy LLC
61	Snowflake Wind Energy Project	Wind	0	Planning	Snowflake Wind Energy Facility LLC
65	Sunshine Solar Farm	Solar	20	Planning	Pacific Blue Energy Corp
66	Gray Mountain Site 1B	Wind	250	Planning	Navajo Nation/Navajo Tribal Utility Authority
67	Gray Mountain Site 1A	Wind	250	Planning	Navajo Nation/Navajo Tribal Utility Authority
68	Paragon-Bisi Solar Ranch	Solar	4000	Planning	Navajo Nation/Navajo Hopi Land Commission Office
78	Sunset Mountains Wind Project	Wind	100	Planning	Hopi Tribe
79	Native American Photovoltaics (NAPV)	Solar	0	Planning	Navajo Nation/Native American Photovoltaics
85	Blindspring Ranch Solar Photovoltaics	Solar	0	Proposed	Navajo Nation
89	40MW Solar Demonstration Plant	Solar	40	Proposed	Hopi Tribe
90	Sunshine Wind Park	Wind	60	Planning	Hopi Tribe
95	NGS Solar Alternatives-USBR	Solar	503	Proposed	USBR-GIS Analysis, approximated to be 503 MW
101	Pinion Unified School District	Solar	0	Proposed	Pinion Unified School District, Black Mesa Solar
102	Pinion Health Center	Solar	1	Proposed	Pinion -Health Center, Black Mesa Solar
103	Forest Lakes Chapter House	Solar	0	Proposed	Forest Lakes Chapter, Black Mesa Solar
133	Toshiba 20 MW Interconnection	Solar	20	Proposed	Toshiba Corporation, Navajo Nation, NTUA
175	NGS Natural Gas Combined Cycle	Natural Gas	590	Proposed	Black Mesa Trust (Glen Manygoats Fwamale)
177	Hopi Tawa Solar Energy Project	Solar	4400	Proposed	Tribal Project Advisors & Associates
178	Tuba City Solar Phase I	Solar	NA	Proposed	Southwest Renewable Energy Corporation, LLC
179	Communities Under Phase II	Multiple Technologies	NA	Proposed	Southwest Renewable Energy Corporation, LLC
182	Black Mesa Snowfields Solar	Solar	<25	Proposed	Cooperative with Navajo, Hopi and Peabody
184	Kayenta Solar	Solar	15	Proposed	NTUA Solar Project Development
185	Burnside Junction Solar Project	Solar	15	Proposed	NTUA Solar Project Development
186	Twin Arrows Navajo Casino Resort Solar	Solar	15	Proposed	USBR-Planning Option
187	BOR Pumping Well #1 Solar Option	Solar	15	Proposed	USBR-Planning Option
188	BOR Pumping Well #3 Solar Option	Solar	15	Proposed	USBR-Planning Option
189	Lmapi Area Solar Options	Solar	15	Proposed	USBR-Planning Option
190	Cudei NM Solar Option	Solar	15	Proposed	NTUA Solar Project Development
191	Shiprock Switch-Natural Gas/Solar/Wind	Multiple Technologies	1000	Proposed	Undetermined

UT CO AZ NM

Navajo Nation

Hopi Tribe

Glen Canyon 1,312 MW

Navajo 409.5 MW

Kayenta Complex

Black Mesa Complex

San Juan Generating Station 1,848 MW

Four Corners 2,040 MW

Arrenas 40.3 MW

Ignacio 67 MW

Milagro Cogeneration 20.8 MW

Navajo Dam 30 MW

Escalante 257 MW

Cholla 1,387.8 MW

Dry Lake Wind 128.1 MW

Catalyst Paper Snowflake 70.6 MW

Snowflake White Mountain Power 27.2 MW

Coronado 821.8 MW

BW-1

BW-2

BW-3

Southern Ute Tribe

Ute Mountain

Jicarilla Apache

Zuni Pueblo

Zuni

Petrified Forest

Fort Defiance

Window Rock

Crownpoint

N

W

E

S

0 25 50 Miles

Existing Utilities Infrastructure

- Electric Power Generation Plants

Electrical Substations

- 500 kV
- 345 kV
- Under 100 kV

In-Service Transmission Lines

- 500 kV
- 345 kV
- 230-287 kV
- 100-161 kV
- Under 100 kV
- Step-Up

NTUA Priority Overhead Lines

- 450 kV
- 340 kV
- 280-315 kV
- 100-180 kV
- Under 100 kV

Natural Gas Pipelines

- Operating
- Cancelled
- Natural Gas Receipt/Delivery Points

Renewable Energy Projects

- Solar
- Wind
- Natural Gas
- Biomass
- Multiple Technologies
- BOR C-Aquifer Pumping Wells
- Leupp to Dilkon Pipeline (BOR)

Water Supply Pipelines (BOR Proposed)

- Intake Easement to LeChee
- Page to LeChee Option A
- Page to LeChee Option B
- Page to LeChee Option C
- LeChee to Gap
- Gap to Gray Mountain
- Tuba City
- Hopi Alternatives

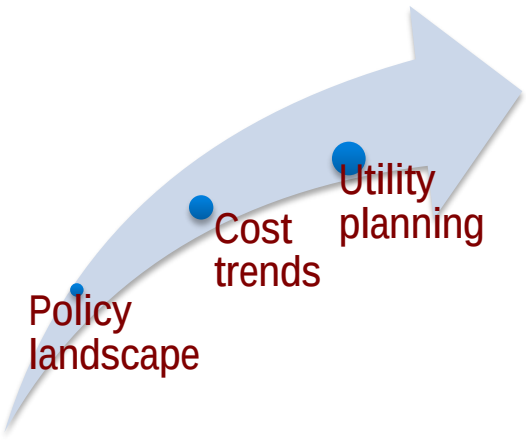
- Twin Arrows Navajo Casino Resort
- Black Mesa Mining Complex
- Kayenta Mining Complex
- Rights-of-Way
- Kayenta Mine Conveyor
- Black Mesa & Lake Powell Railroad
- Hopi Tribe
- Navajo Nation
- Tribal Lands-No CAP Water Allocations

SENSISTIVE INFORMATION-NOT FOR DISTRIBUTION: THIS INFORMATION IS FOR OFFICIAL USE ONLY AND MUST BE PROTECTED. THIS US GOVERNMENT DATA MAY BE EXEMPT FROM FURTHER PUBLIC RELEASE UNDER THE FREEDOM OF INFORMATION ACT (5 U.S.C. 552). THIS INFORMATION MUST BE CONTROLLED IN ACCORDANCE WITH APPLICABLE BUREAU OF RECLAMATION DIRECTIVES. THE FURTHER DISTRIBUTION OF THIS INFORMATION REQUIRES PRIOR APPROVAL FROM AN AUTHORIZED RECLAMATION OFFICIAL.

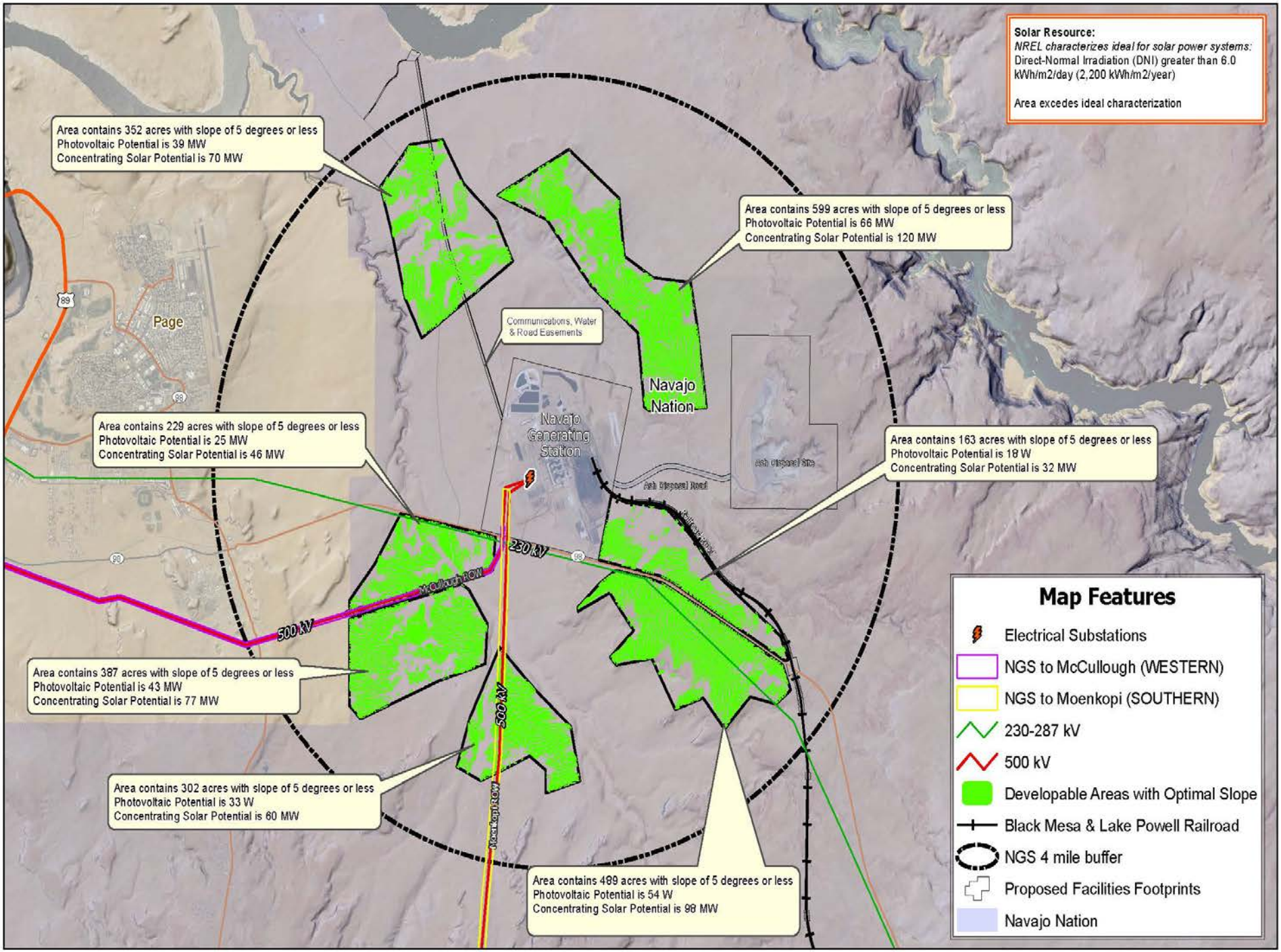
RECLAMATION *Managing Water in the West*

P:\GIS_Projects\NavajoGeneratingStation\14P004AMO1532_BlackMesa\Navajo-Clean Energy Screening\NavajoLE_Projects.mxd

Task 2: Sectoral trends



- **What systemic changes are affecting the results seen in Task 1?**
  - Future technology costs
  - Public policies
- **How are Arizona utilities planning for the future?**
  - New plants
  - Purchased power
  - Plant retirements

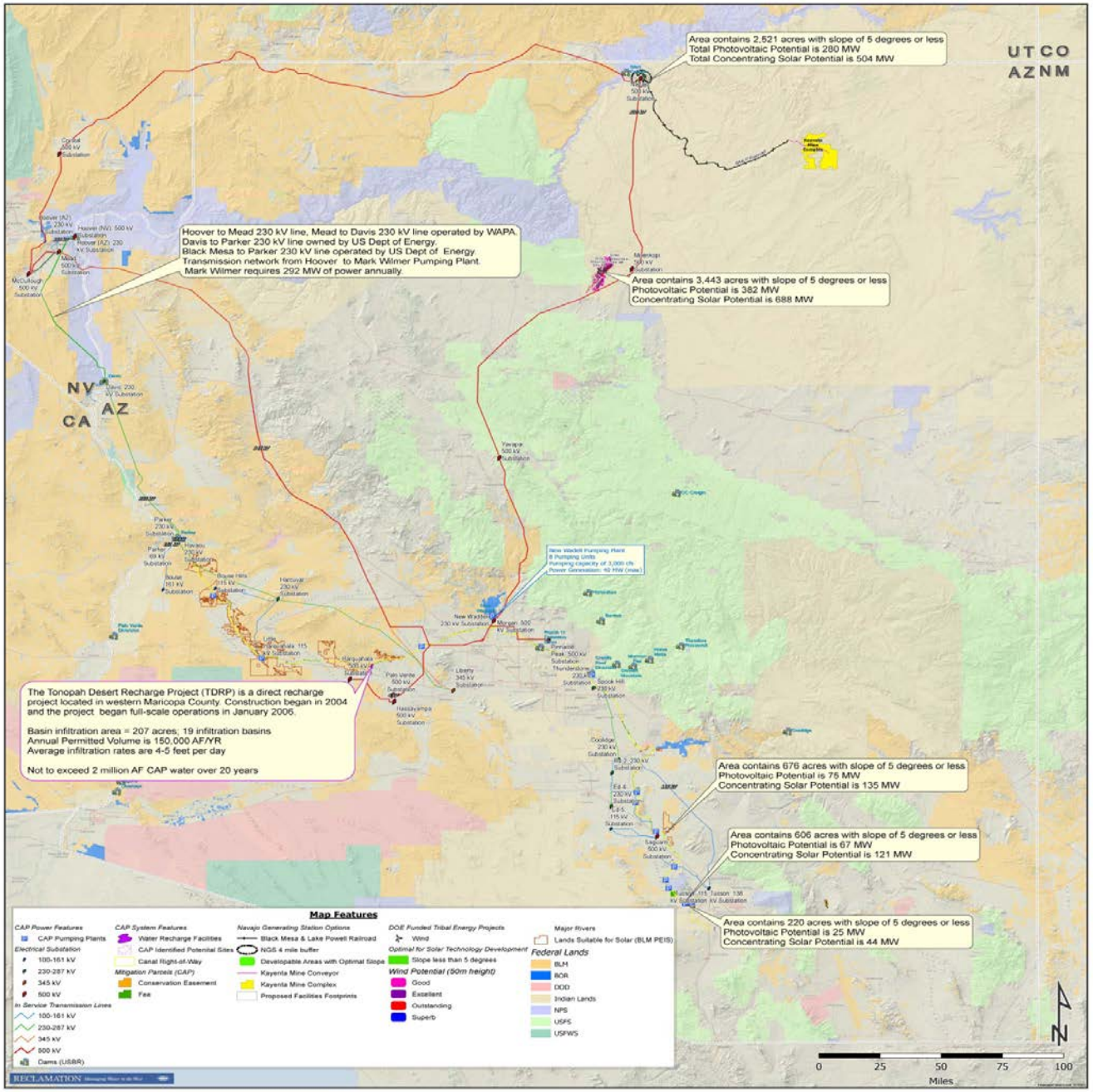

Solar Resource:
NREL characterizes ideal for solar power systems:
Direct-Normal Irradiation (DNI) greater than 6.0 kWh/m2/day (2,200 kWh/m2/year)
Area excedes ideal characterization
Area contains 352 acres with slope of 5 degrees or less
Photovoltaic Potential is 39 MW
Concentrating Solar Potential is 70 MW
Area contains 599 acres with slope of 5 degrees or less
Photovoltaic Potential is 66 MW
Concentrating Solar Potential is 120 MW
Area contains 229 acres with slope of 5 degrees or less
Photovoltaic Potential is 25 MW
Concentrating Solar Potential is 46 MW
Area contains 163 acres with slope of 5 degrees or less
Photovoltaic Potential is 18 W
Concentrating Solar Potential is 32 MW
Area contains 387 acres with slope of 5 degrees or less
Photovoltaic Potential is 43 MW
Concentrating Solar Potential is 77 MW
Area contains 302 acres with slope of 5 degrees or less
Photovoltaic Potential is 33 W
Concentrating Solar Potential is 60 MW
Area contains 489 acres with slope of 5 degrees or less
Photovoltaic Potential is 54 W
Concentrating Solar Potential is 98 MW
Page
Navajo Nation
Navajo Generating Station
Communications, Water & Road Easements
Ash Disposal Site
Ash Disposal Road
Railroad ROW
230 kV
500 kV
McCullough ROW
Moenkopi ROW
Map Features
Electrical Substations
NGS to McCullough (WESTERN)
NGS to Moenkopi (SOUTHERN)
230-287 kV
500 kV
Developable Areas with Optimal Slope
Black Mesa & Lake Powell Railroad
NGS 4 mile buffer
Proposed Facilities Footprints
Navajo Nation

Task 3: Analysis of glidepath options

- **One glidepath may include more than one technology**
  - Federal share of NGS may provide transitional power
- **Utility partnership in a glidepath is not necessary, but is not precluded**

- **Will take into account:**
  - TWG milestones
  - Future cost trajectories, other sectoral factors identified in Task 2

NGS Transmission Facilities and CAP Pumping centers



Pre-commercial resource options

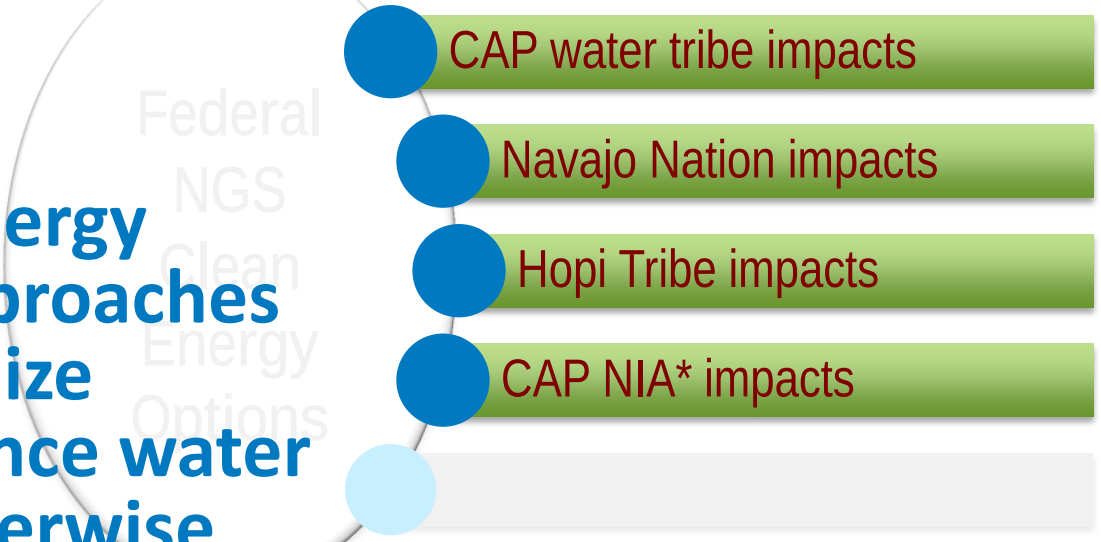
- **Defined as no on-line commercial development to date, but target of significant R&D**
  - Future is speculative, in that there is no commercially validated market data to provide analytical inputs comparable to options that are currently commercial
  - NREL Phase 2 will review status, but will not analyze as a potential glide path option
- **Clean coal**
  - Review the current status of research and development
  - Identify factors affecting the suitability of NGS and the Kayenta Mine as locations for demonstration projects or technology research
- **Small modular reactors**
  - Review the current status of research and development

Task 4: Potential for Surplus Power

- **Analysis of how glidepath options examined in Task 3 might be up-sized to provide surplus power for market sales**
  - Results could help federal agencies formulate proposals to Congress for expanded authorization

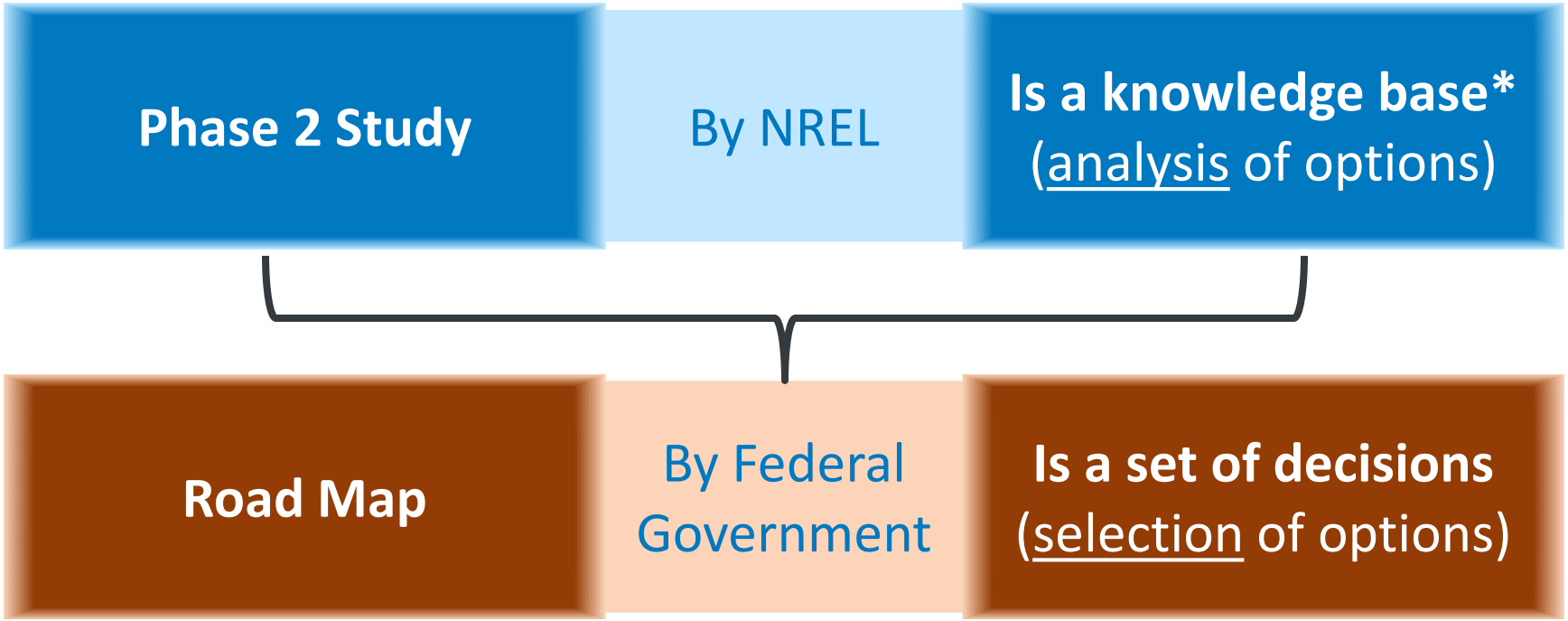
Task 5: Impacts

- **For each option identified in Task 3, break down the impacts on NGS constituencies**
- **Appraise local energy development approaches that could minimize disruption, enhance water delivery, and otherwise promote sustainable development**



Stakeholder outreach and scoping	COMPLETE
Technical memoranda — baseline topics*	Q1–Q3 2015
Technical memoranda — glidepath topics	Q1–Q4 2016
Final published report	Q1 2017
Social media outreach	Q1–Q2 2017

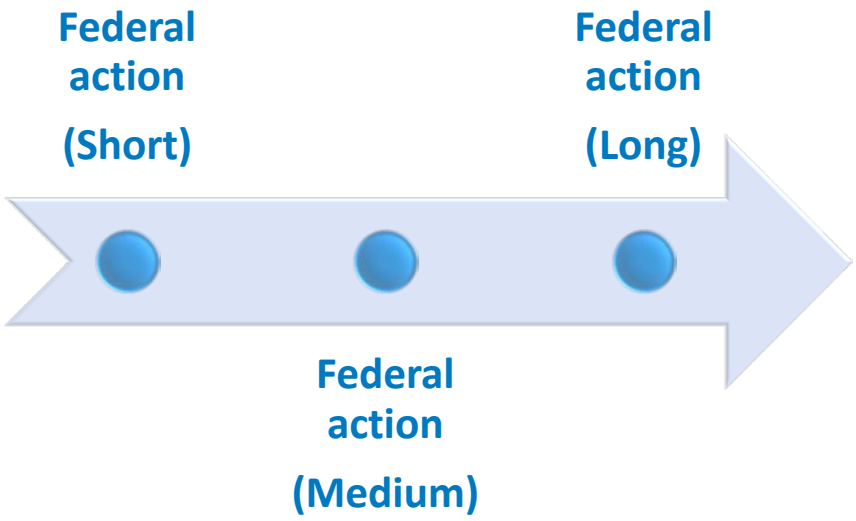
Phase 2 Informs the Federal Road Map



Phase 2 Study will not decide any specific project or federal action

Road Map

With NREL's Phase 2 study as a knowledge base, federal agencies will decide on actions to achieve goals



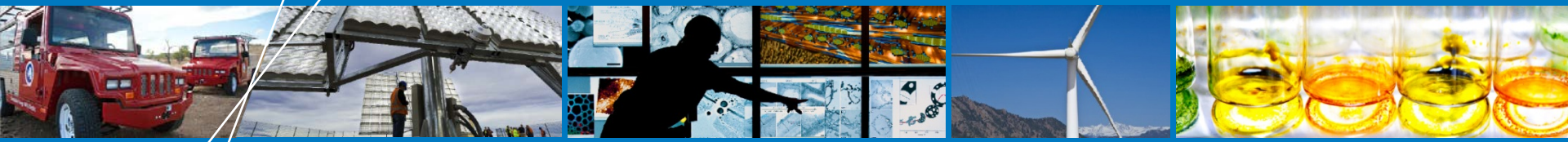
Federal goals

- Clean, affordable, reliable power
- Affordable, sustainable water supplies
- Sustainable economic development
- Minimize negative effects on tribes, others who receive benefits from NGS

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Questions?



Kevin Black, USBR

kblack@usbr.gov