HPX
High Plains Express

Commercial Committee Results

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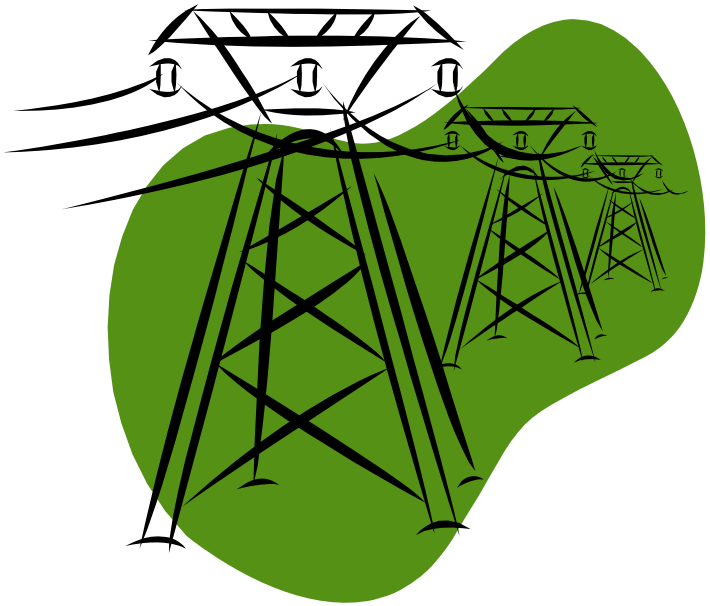
Committee Chairman

Agenda

1. Overview of committee work
2. Overview of analysis
3. Modeling methodology
4. Results
5. Other benefits
6. Commercial issues
7. Commercial findings

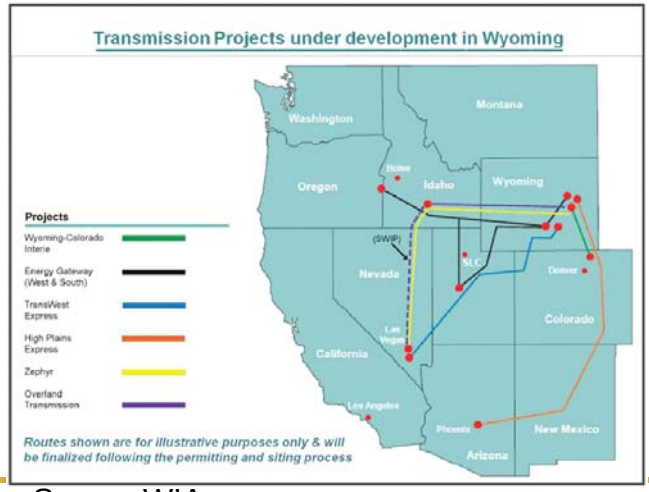


Stage 2 Commercial Work

- Primary focus on quantifying benefits and calculating benefit/cost ratios
  - Use scenarios to evaluate assumption risk
  - E3 conducted the evaluation
- Examine commercial structures

Stage 2 Studies

- Please keep in mind:
  - Technical and commercial studies conducted in parallel
    - Configurations, transfer capability, and costs are not always consistent
  - Assumptions based on best information at the time
    - Prices have changed since the studies were initiated
- Not Studied:
  - Value of resource diversity
  - Value of avoided transmission upgrades
  - Commercial impact of proposed transmission
    - Gateway, Overland, TWE, Zephyr SWIP, MSTI, etc.



Source WIA

E3 Introduction

Energy and Environmental Economics (E3) has significant planning, policy and market experience in the West.

Regulatory / Policy

- EE avoided costs for CA utilities
- Calculate MPR for CPUC
- 33% RPS and GHG studies for CPUC
- Advising CPUC on long-term planning
- CA Solar Initiative cost-effectiveness
- EPA National Action Plan for efficiency
- 2007 Idaho Energy Plan

Utility

- WECC Energy Imbalance Market Study
- WEIL Group "Towards 2020" study
- BC-California renewable energy partnership
- Expert testimony for CAISO on Sunrise line
- Capital cost model for TEPPC
- WECC SPSG technical support
- RTO West market design

Cleantech / Emerging Technologies

- Analysis of market opportunities for emerging technologies such as renewables, distributed generation, demand response, smart grid, energy storage, electric vehicles
- Clients include EPRI, BrightSource Energy, First Solar, Hydrogen Energy International, VC clients

HPX Primary Benefits

- The construction of HPX would result in a number of benefits to participants. E3 examined the following:
  1. **Reduced renewable procurement cost:** the line would enable the development and delivery of lower-cost remote renewable resources to participants
  2. **Capacity sharing benefits:** HPX would facilitate greater sharing of capacity resources to meet local peak loads, deferring investment in new fossil plants
  3. **Dispatch benefits:** HPX would lower the costs of serving loads by alleviating transmission constraints in the WECC, enabling more efficient operation of fossil plants
  4. **Macroeconomic benefits:** the construction of the line and associated resources would bring jobs and tax base to each state

HPX Secondary Benefits

- The addition of transfer capacity between Wyoming and Arizona would also have operational and reliability benefits for the region as a whole. Though not modeled here, these could include:
  1. Reduced integration needs due to increased diversity
  2. Deferral of T&D investments needed for reliability
  3. Increased operational reliability, reduced risk of outages
  4. Increased access to market trading hubs
  5. Lower fuel prices from reduced demand due to increased dispatch efficiency of fossil resources

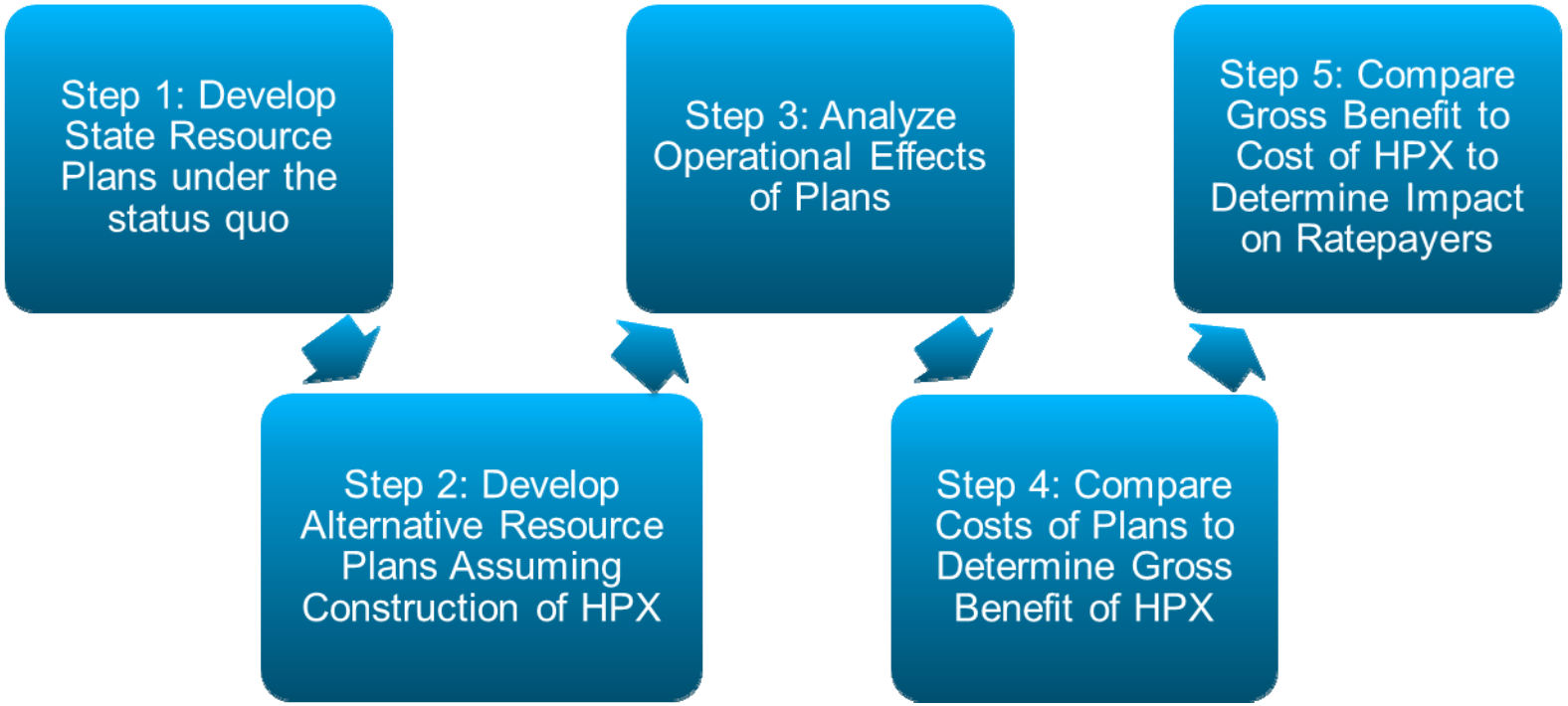
Macroeconomic Benefits

- Construction
  - On-Site Jobs and Income (Direct)
  - Supplier Jobs and Income (Indirect)
  - Increased Household Spending (Induced)
  - Taxes
- Transmission ROW Easements
  - Household Income (Direct)
  - Increased Household Spending (Induced)
  - Taxes
- Operation
  - On-Site Jobs and Income (Direct)
  - Supplier Jobs and Income (Indirect)
  - Increased Household Spending (Induced)
    - Increased Employment
    - Lower Electricity Costs to Households
  - Taxes

HPX
High Plains Express

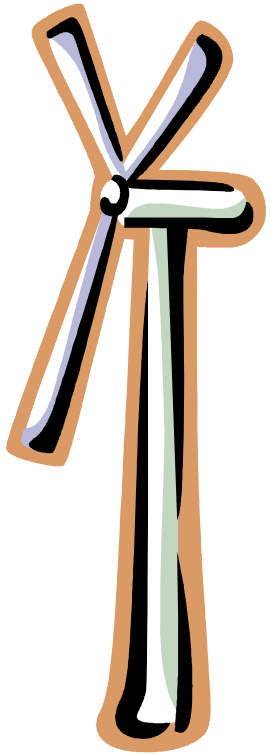
MODELING METHODOLOGY

Modeling Ratepayer Impacts



Step 1: Resource Plans

- Without the construction of HPX, each state must build enough local resources to meet its RPS target as well as its growth in demand
  - Resource plans are developed to meet resource gaps
- In each state, E3 created a plausible portfolio of locally-available renewable resources
  - Arizona is heavily dependent on solar resources
  - New Mexico and Colorado rely primarily on wind
- Once each state has satisfied its RPS target with local resources, conventional resources are added to the portfolio to meet any residual demand for energy or capacity



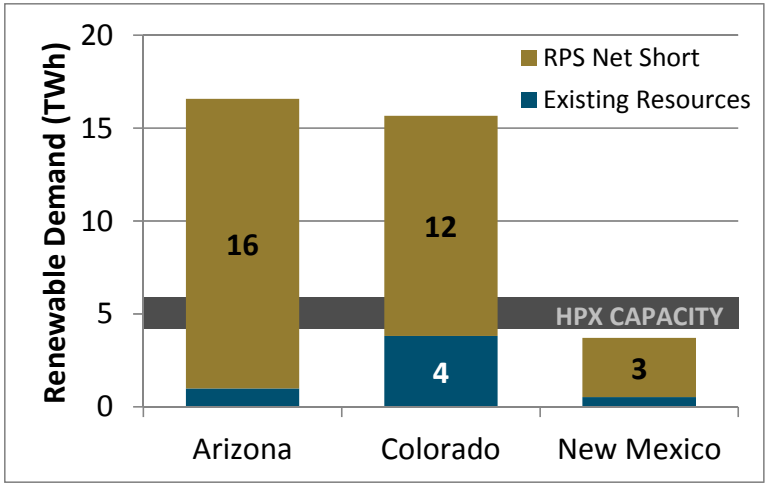
Step 1: Renewable Demand

- Arizona, Colorado, and New Mexico are each pursuing aggressive RPS targets
- In order to ensure appropriate long-run valuation of the HPX line, E3 assumes that each state achieves compliance with its 2025 RPS goal by the snapshot year of 2020

RPS Targets by State and Utility Type (% of Retail Sales)

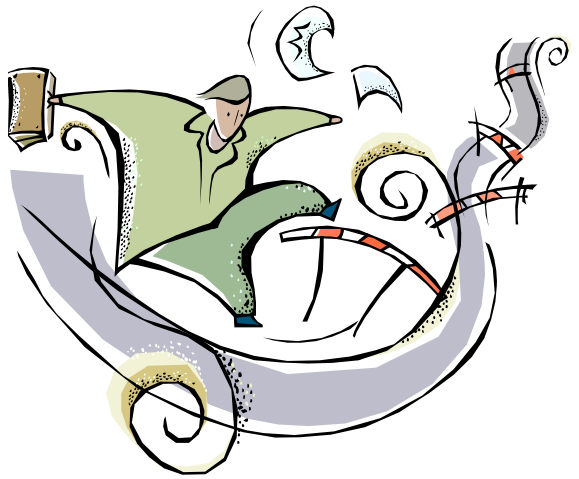
	Arizona	Colorado	New Mexico	Wyoming
IOU	15%	30%	20%	5%
Public	15%*	10%	0%	0%
Coop	15%	10%	10%	5%
Average	**14.4%**	**21.6%**	**15.6%**	**4.8%**

* SRP is assumed to achieve a 15% RPS target by 2025; all other Arizona publics are modeled with a 7.5% target



Step 1: RPS Policy

- The aggressive targets in Arizona, Colorado, and New Mexico include strong incentives for in-state development
- These restrictions reduce the benefits associated with interstate transmission development



State	Policy
Arizona	**30% set-aside for Distributed Generation (DG)**
Colorado	**10% set-aside for DG; 125% credit for in-state resources**
New Mexico	**3% set-aside for DG; 10% set-aside for biomass; preference for in-state resources**

Step 2: Supply Curve

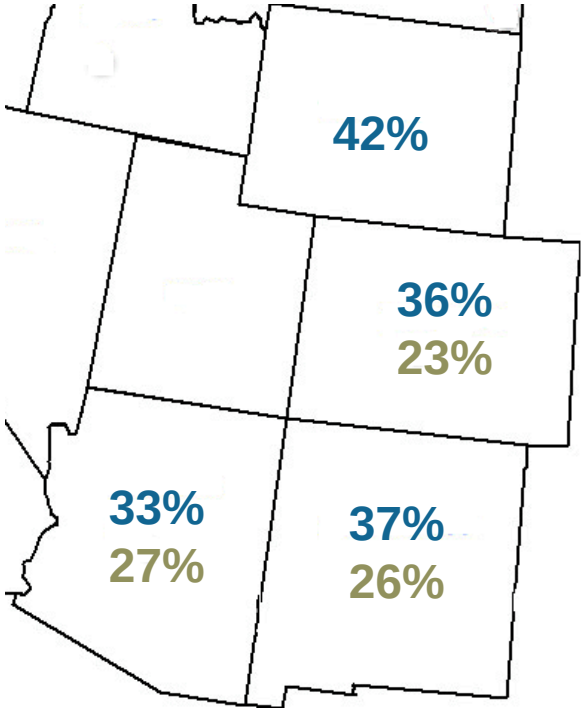
- Resources are ranked in the supply curve based on "Ranking Cost" – cost adjusted by ratepayer value
- Ranking costs include adjustments for the different characteristics of each resource
  - E.g., wind produces more energy at night and during winter, while solar produces more energy during daylight hours

	Busbar Cost	Integration Cost	Energy Value Adjustment	Capacity Value Adjustment	Ranking Cost
Wyoming Wind	$ 68.97	$ 6.00	$ (3.77)	$ (16.55)	**$ 95.29**
New Mexico Wind	80.09	6.00	(2.25)	(16.77)	**105.11**
Colorado Wind	81.69	6.00	(3.79)	(16.16)	**107.64**
Arizona Wind	89.22	6.00	(1.38)	(16.83)	**113.43**
New Mexico Biomass	112.82	-	(1.60)	0.16	**114.26**
Colorado Biomass	126.24	-	(2.86)	0.29	**128.81**
Wyoming Biomass	134.51	-	3.72	0.38	**130.41**
California Geothermal	136.27	-	-	(1.26)	**137.53**
Arizona Large Scale Solar	171.28	6.00	6.07	31.89	**139.32**
Arizona Distributed Solar PV	234.56	6.00	5.32	20.93	**214.31**

Step 2: Resource Performance

- Develop a supply curve of potential resources that could be developed along HPX
- Select the least-cost resources to displace expensive local resources in each state's original portfolio
- A new mix of conventional generation is selected in each state based on the characteristics of the renewable portfolio with HPX

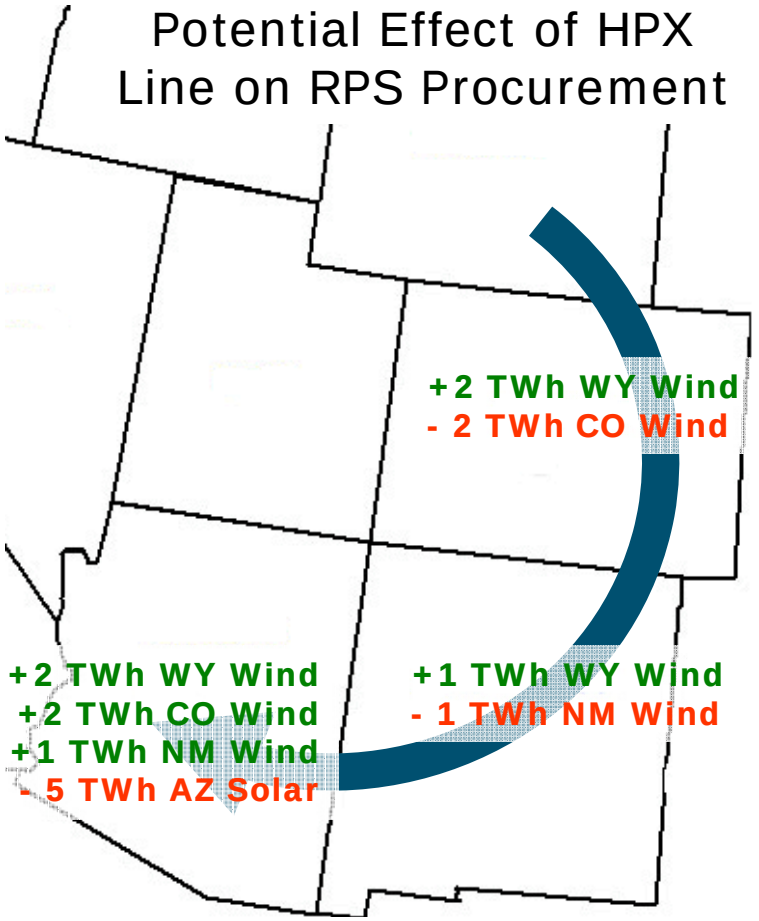
Representative Capacity Factors by State (**Wind** & **Large Scale Solar**)



Data source for renewable resource cost and availability: WREZ

Step 2: Allocation of Resources

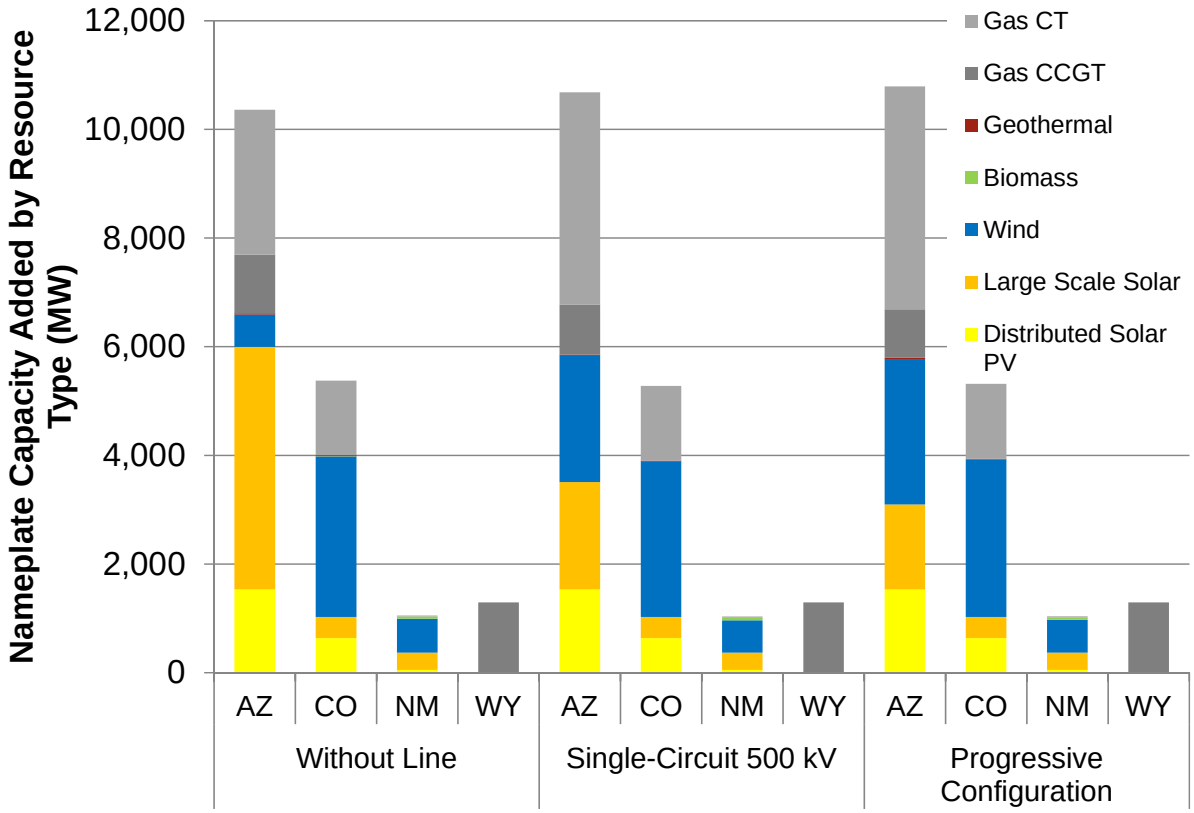
- HPX would allow new low-cost wind in Wyoming to replace higher-cost resources in downstream states
- E3 allocated the low-cost Wyoming wind to each of the states in proportion to its need
- This allows surplus wind from Colorado and New Mexico to flow to Arizona



Distribution of claims above is based on the single circuit configuration

Step 2: Resource Plans

- This process results in plausible resource plans for each state in 2020 with and without HPX
  - These plans serve as the basis for production simulations

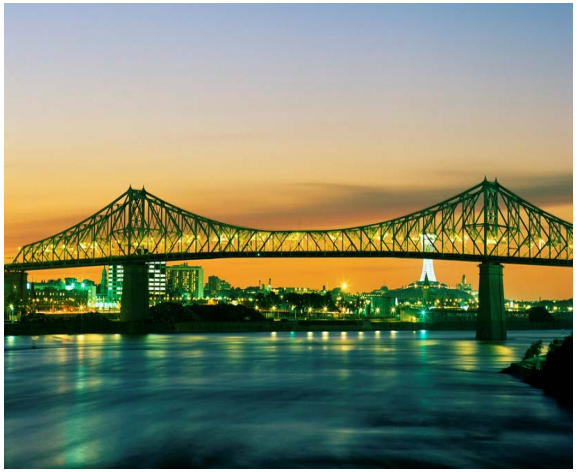


Steps 3 & 4: Dispatch Benefits

- Resource plans used for production cost simulation using GridView
  1. 2020 WECC simulation without HPX
  2. 2020 WECC simulation with HPX
- Simulations estimate dispatch benefits from HPX on a WECC-wide basis

Steps 3 & 4: Capacity Benefits

- Increased transmission capacity allows greater sharing of resources for meeting critical peak loads
- Without HPX: Assume each region builds to meet peak load growth between 2008 and 2025
  - Add resources to meet growth in ***non-coincident*** peak loads for each load area (WAPA, Xcel, PNM, Arizona)



- With HPX: New resources are shared to the extent allowed by load diversity and new transmission capacity
  - Add resources to meet growth in ***coincident*** peak loads for combined load areas
- Reliability Benefit = (Non-Coincident MW Growth – Coincident MW Growth) * CT Carrying Cost

Step 5: Ratepayer Impacts

- The ratepayer benefit to each state of the HPX line is:

  Statewide revenue requirement without HPX line

  minus

  Statewide revenue requirement with HPX line

2020 Revenue Requirement

+ Transmission & Distribution costs
+ Costs of existing Generation
+ Fixed costs of new Generation
+ Generation production costs
+ Market purchases/sales

= 2020 Revenue Requirement

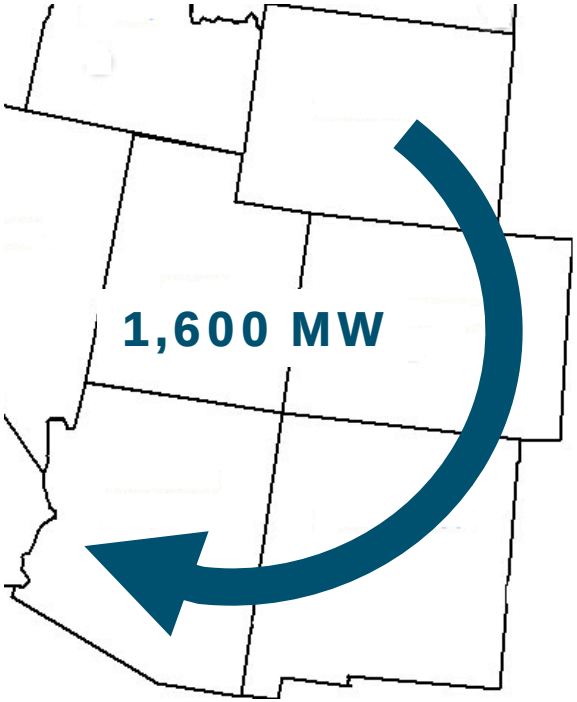
Step 5: Cost Allocation of New Transmission

- The method of cost allocation for the HPX line has not yet been determined
- E3 modeled the line's benefits independent from its costs
- For this analysis, costs were allocated to each state in proportion to the benefit it receives

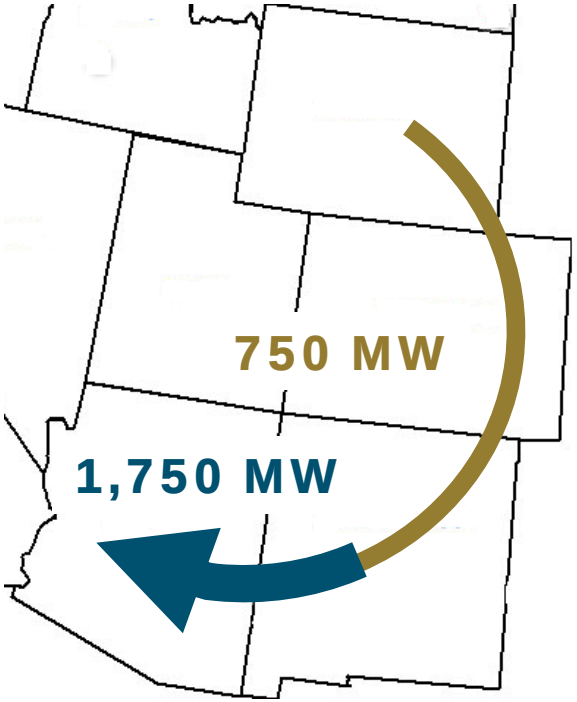
RESULTS OF RATEPAYER ANALYSIS

Transmission Configurations

Single-Circuit 500 kV Line
$3.4 billion
$424 million/yr



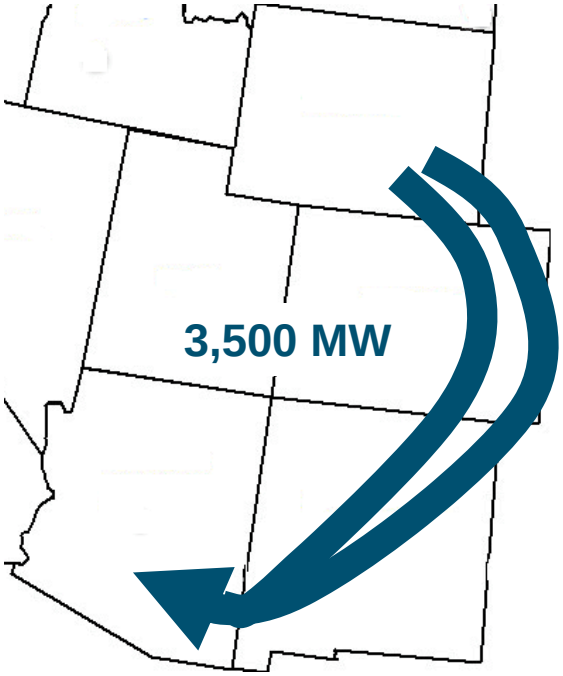
Single-Circuit 500 KV Line, Progressive Configuration
$2.48 billion
$309 million/yr



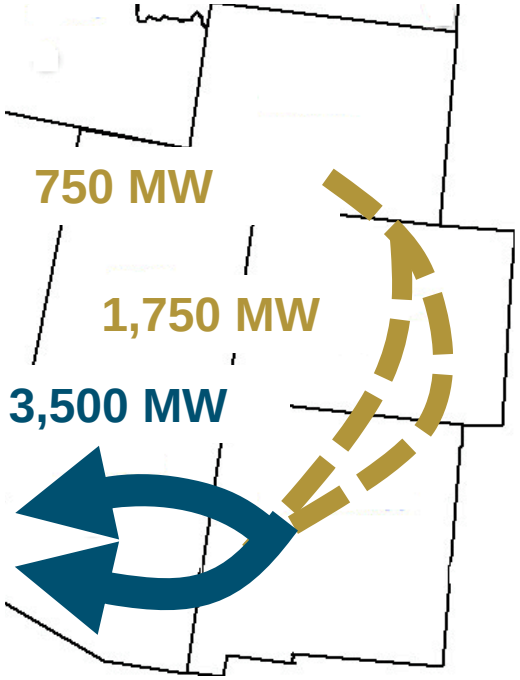
500 kV 345 kV

Transmission Configurations

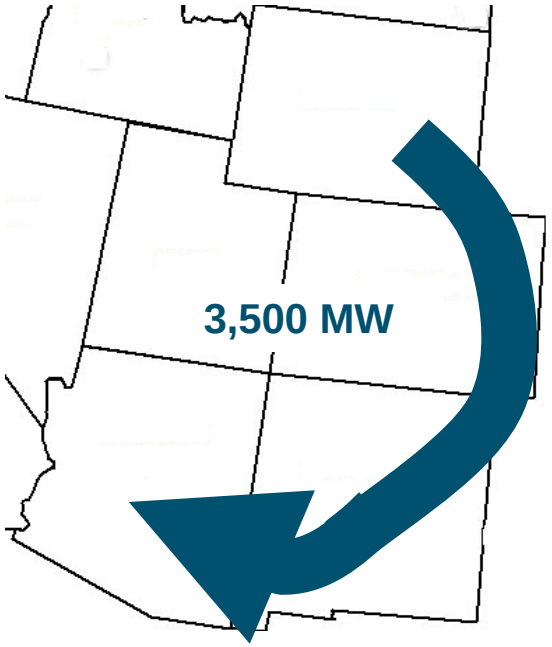
Parallel 500 kV Lines
$5.524 billion
$687million/yr



Parallel 500 kV Lines, Progressive Configuration
$4.95 billion
$618 million/yr



Double Circuit 500 kV Line
$4.125 billion
$515 million/yr



500 kV 345 kV

Line Parameters

		Single 500 kV Line	Single 500 kV Line, Progressive Configuration
Capital Cost (million $)		$3,400	$2,480
Annual Cost (million $)		$424	$309
Transfer Capability (MW)	WY to CO	1,600	750
	CO to NM	1,600	750
	NM to AZ	1,600	1,750

		Parallel 500 kV Lines	Parallel 500 kV Lines, Progressive	Double-Circuit 500 kV Line
Capital Cost (million $)		$5,524	$4,950	$4,125
Annual Cost (million $)		$687	$618	$515
Transfer Capability (MW)	WY to CO	3,500	750	3,500
	CO to NM	3,500	1,750	3,500
	NM to AZ	3,500	3,500	3,500

* - Parameters for the Single-Circuit 500 kV Line are based on the work of the Technical Committee. Values for other configurations are E3 estimates.

Single-Circuit 500 kV Line

- Across the four participant states, the one corridor single-circuit configuration would result in a net benefit to ratepayers totaling $49 million per year (based on 2020 test year)
- Base case benefit/cost ratio = 1.12
- The most substantial portion of this benefit is accounted for by reductions in the costs of renewable procurement

Regional Cost of Meeting Growth and RPS Targets (millions of 2008 dollars)			
	Without HPX	With HPX	Cost (Benefit)
Cost of New Renewable Resources	$ 4,273	$ 3,658	$ (615)
Fixed Costs of New Conventional Resources	$ 1,059	$ 1,212	$ 153
Integration Costs for New Intermittant Resources	$ 179	$ 179	$ -
Variable Costs of Contracted Generation	$ 4,783	$ 4,758	$ (24)
Market Purchases Required for Balancing	$ 144	$ 202	$ 58
Reliability Benefits	$ -	$ (45)	$ (45)
Gross Regional Benefit	**$ 10,437**	**$ 9,964**	**$ (473)**
HPX Line Cost			$ 424
Net Regional Benefit from HPX Line			**$ (49)**

State-by-State Benefits Single-Circuit 500 kV Line

- The benefits associated with the line result in reduced annual revenue requirements in each state
- The majority of the benefits accrue to Arizona ratepayers

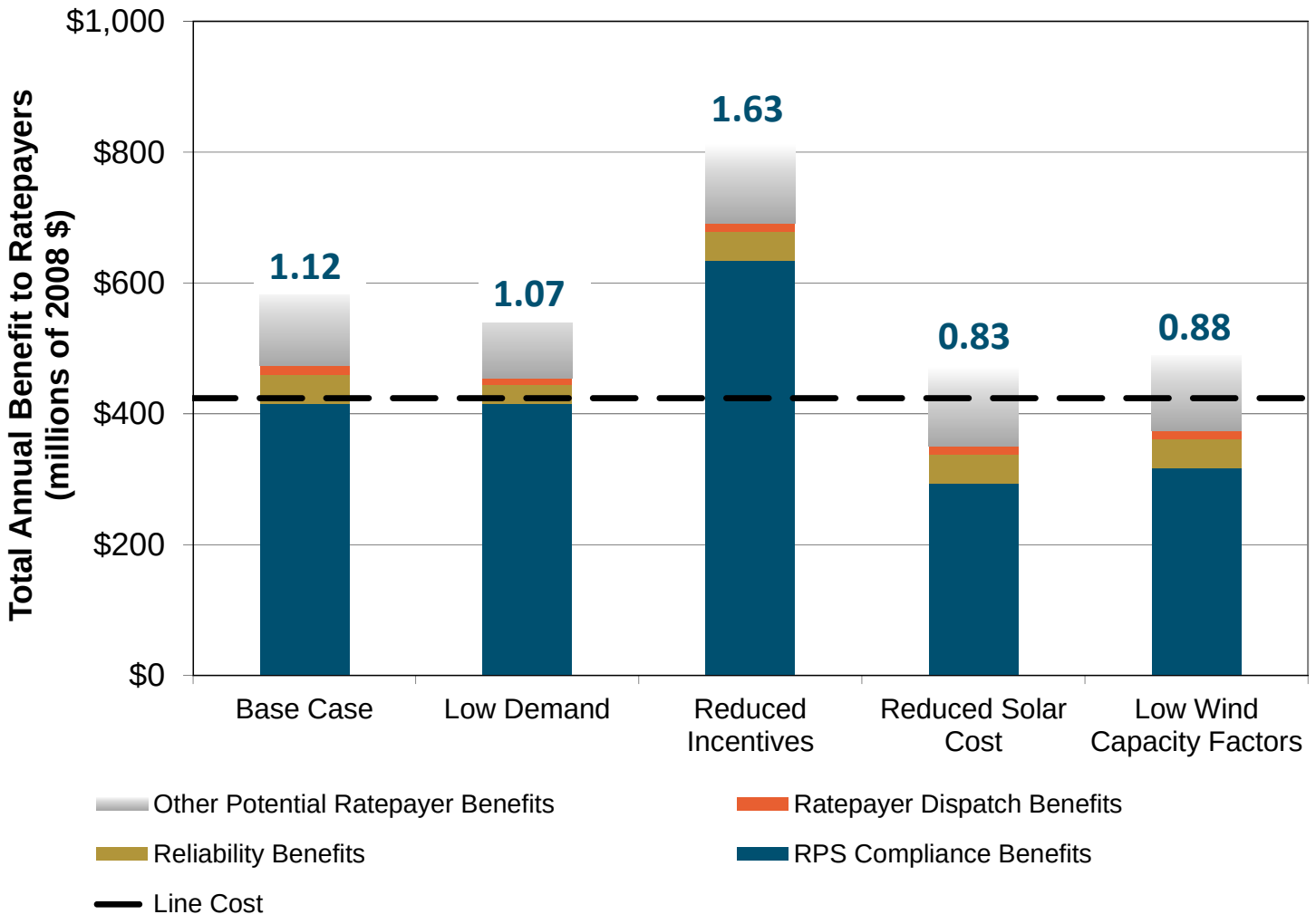
Revenue Requirement and Retail Rate Impacts by State

	Arizona	Colorado	New Mexico	Wyoming	Total
Statewide Revenue Requirement without HPX (million $)	$ 12,035	$ 7,194	$ 2,351	$ 1,017	$ 22,598
Cost Allocation of HPX Line (million $)	$ 369	$ 43	$ 8	$ 4	$ 424
Statewide Revenue Requirement with HPX (million $)	$ 11,993	$ 7,189	$ 2,350	$ 1,017	$ 22,549
Ratepayer Savings with HPX (million $)	$ (43)	$ (5)	$ (1)	$ (0)	$ (49)
Average Retail Rate without HPX (¢/kWh)	11.7	10.6	10.1	5.8	10.7
Average Retail Rate with HPX (¢/kWh)	11.7	10.6	10.1	5.8	10.7
Percent Change in Retail Rate (%)	-0.36%	-0.07%	-0.04%	-0.05%	-0.22%

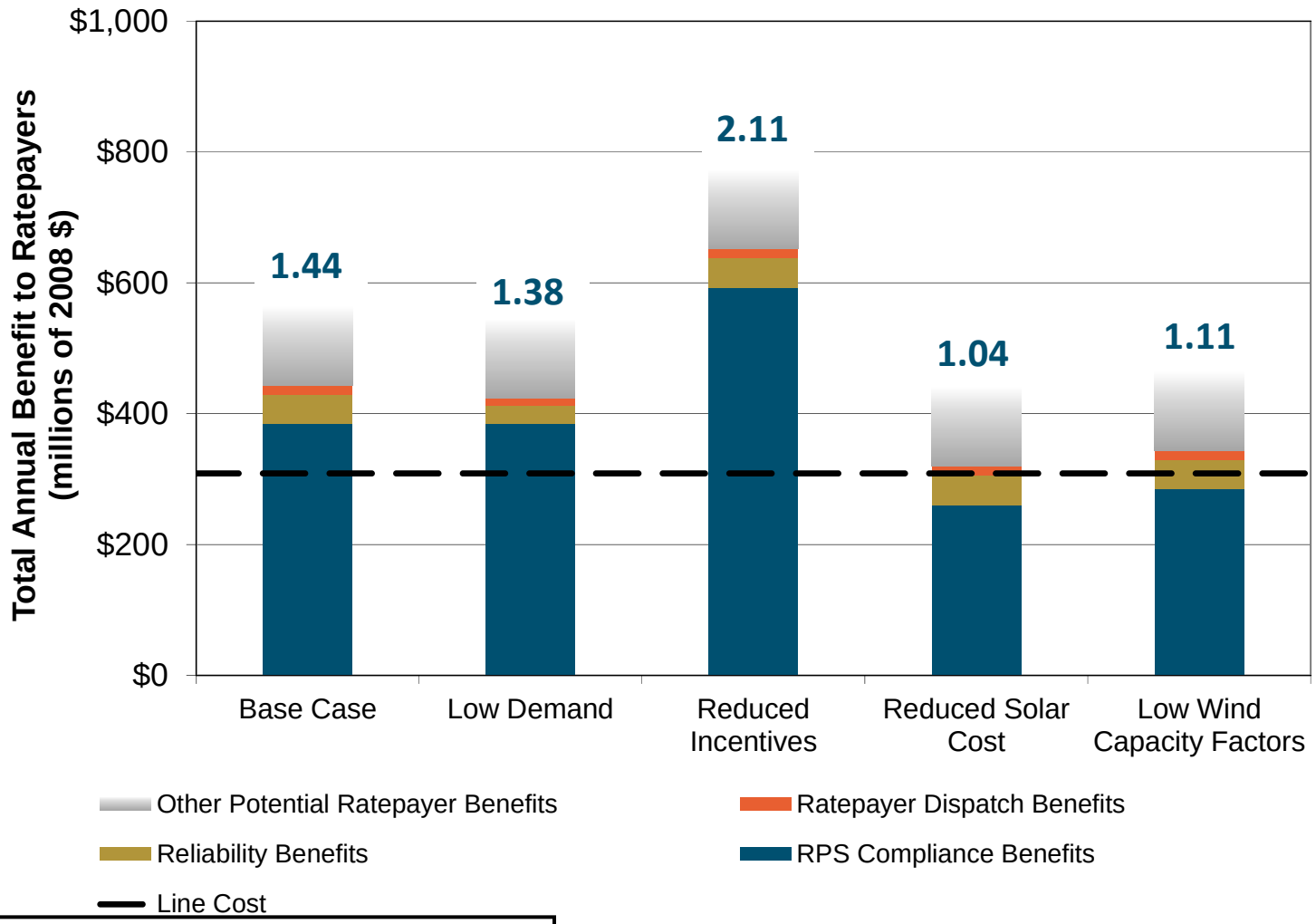
Sensitivities Examined

- **Low-Demand** – Reduced load growth leads to lower demand for renewables, limiting the high cost resources that can be displaced by low-cost resources delivered via HPX, reduced growth rate by 0.5% and increased AZ solar set aside by 1,000 MW
- **Tax Incentives Phased Out** – For base case analyses, E3 assumes the continuation of current tax incentives for wind and solar. This sensitivity assumes expiration of most incentives in 2016.
  - Production Tax Credit (PTC) for wind expires, Investment Tax Credit (ITC) for solar reverts from 30% of qualifying investment to permanent level of 10%
- **Low Solar Cost** – A decline in the cost of solar will reduce the benefits of displacing solar with wind delivered via HPX, assumed a reduction of 15% from base case
- **Low Wind Capacity Factors** – Reduced capacity factors by 5%

Single-Circuit 500 kV Line

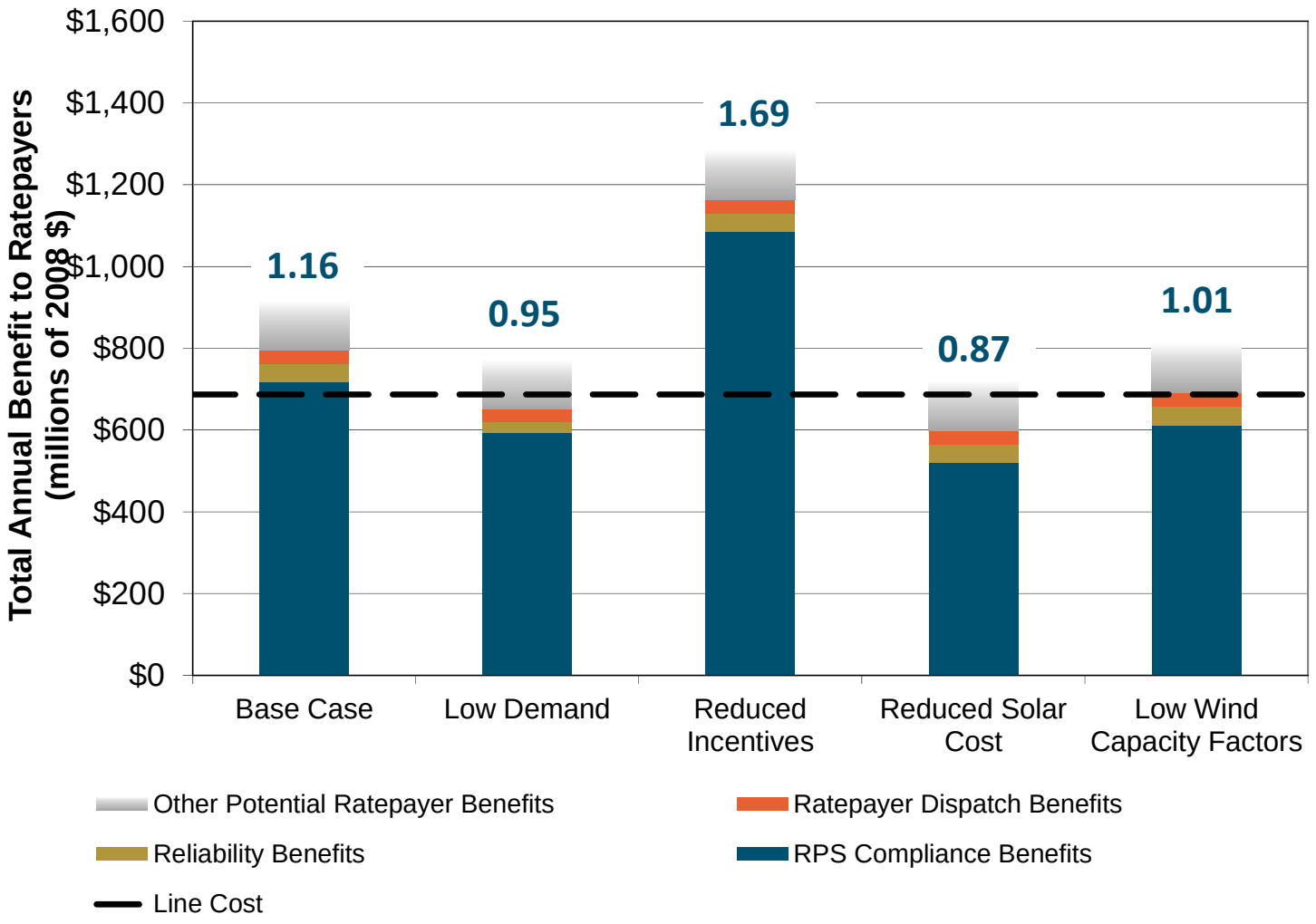


Single-Circuit 500 kV Line, Progressive Configuration*

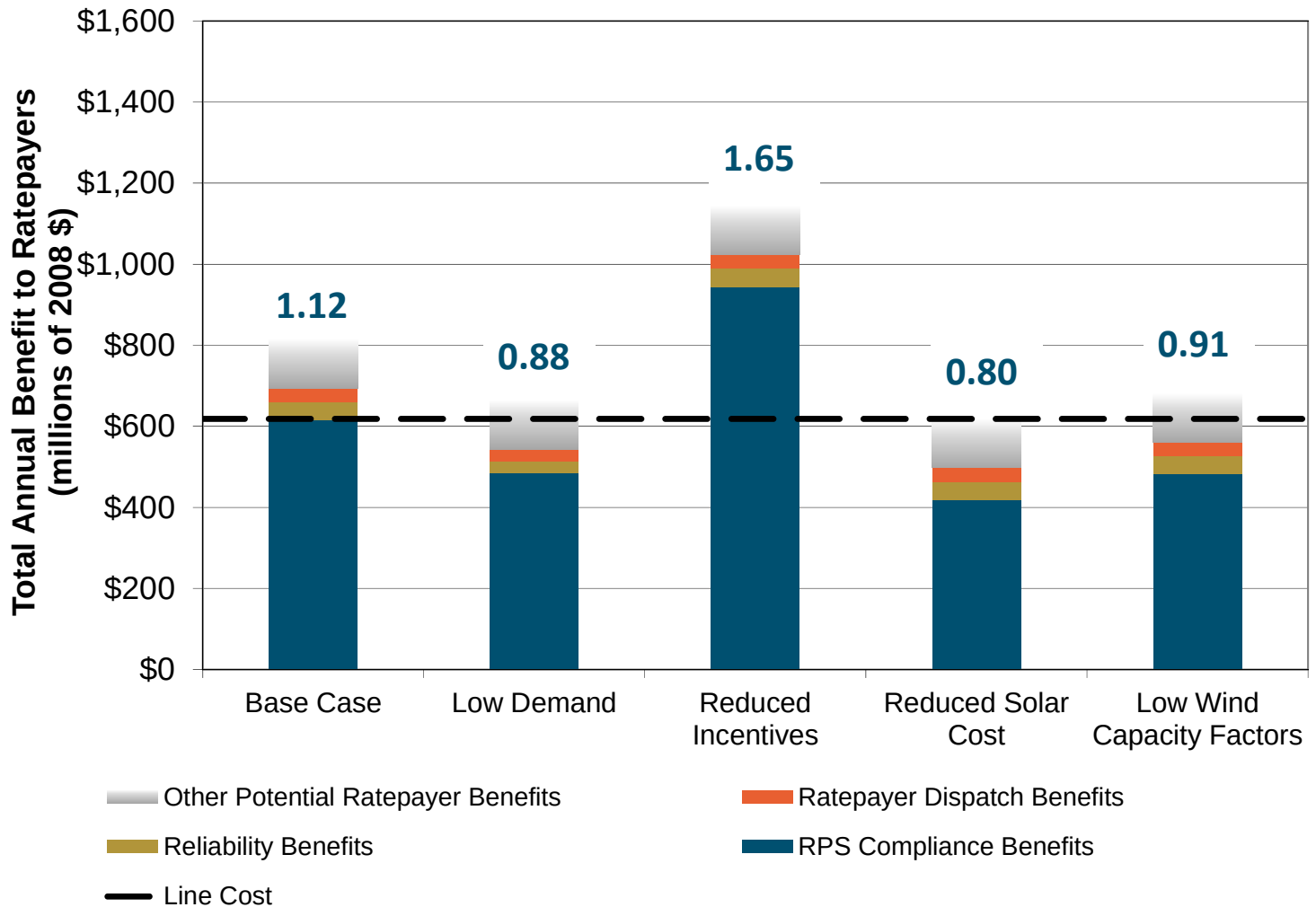


* Technical committee results would change ratios

Parallel 500 kV Lines

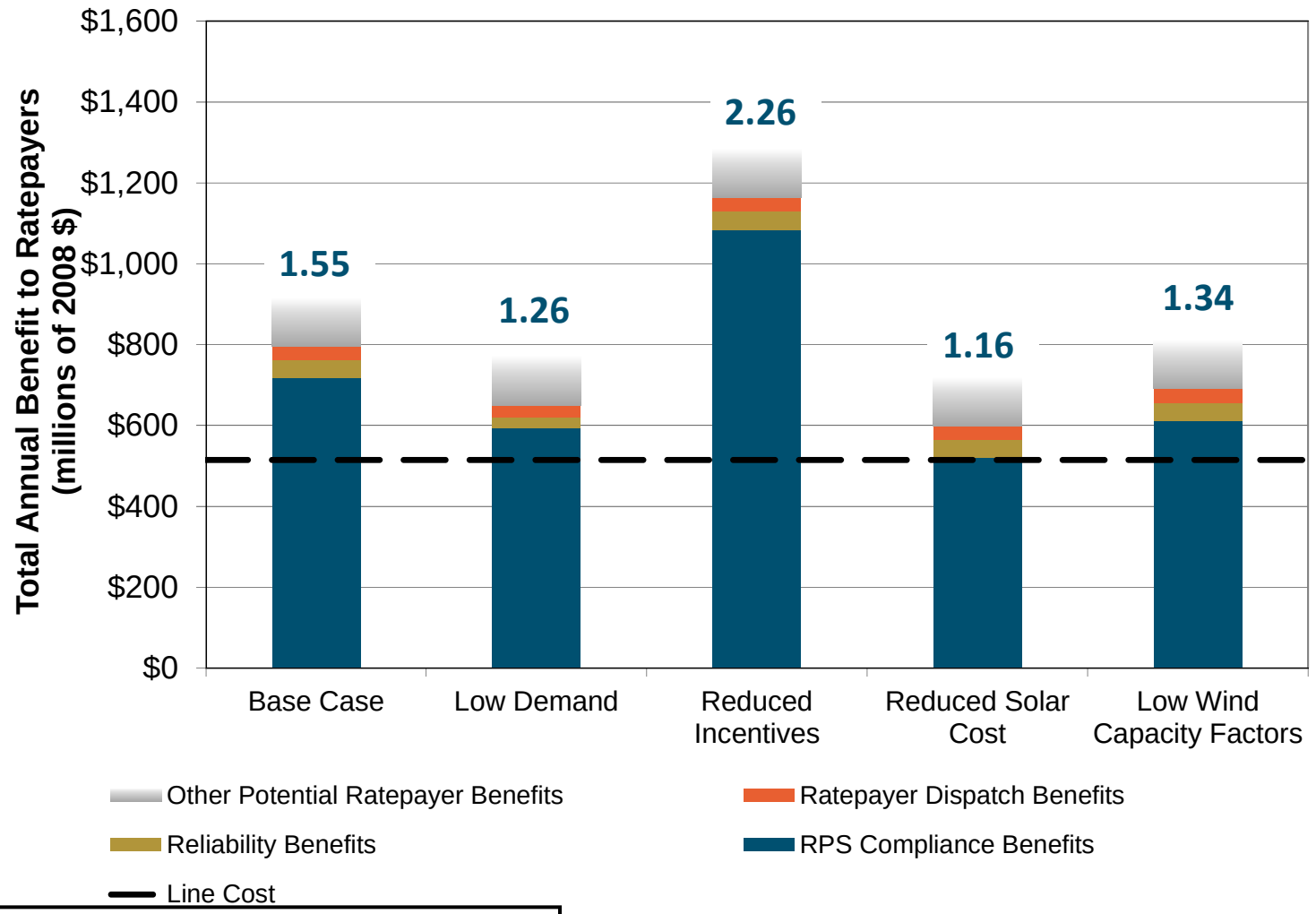


Parallel 500 kV Lines, Progressive Configuration*



* Not studied by technical committee

Double-Circuit 500 kV Line



* Technical committee results would change ratios

ADDITIONAL BENEFITS

Macroeconomic Benefits

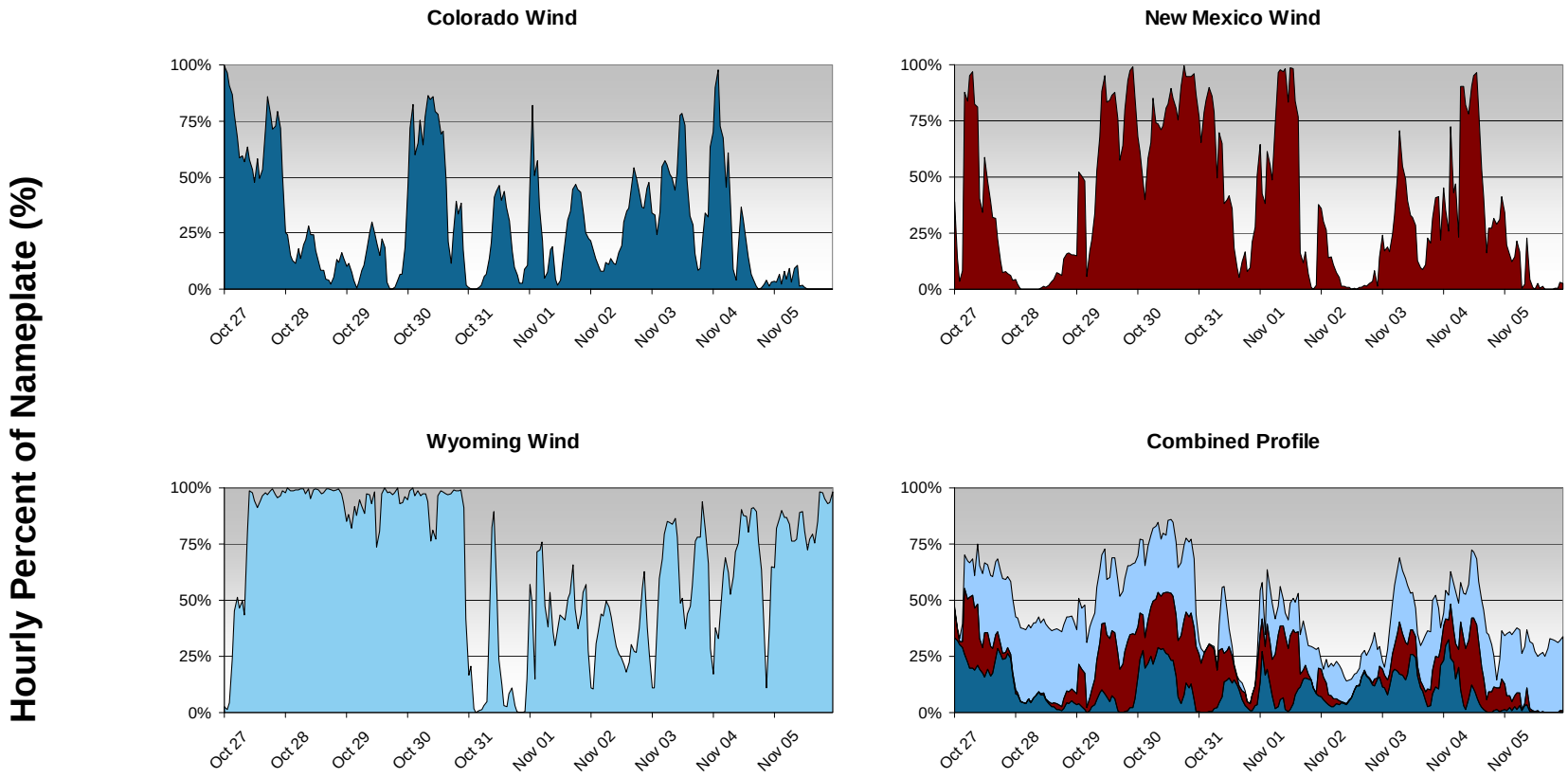
- Cardno Entrix estimated the macroeconomic benefits (jobs, tax revenue, etc.) to upstream states using the Implan model
- Estimates include the effect of the new transmission and generation facilities

	Wyoming	Colorado	New Mexico
Construction Phase	**Jobs:** 9,100-16,900 **Income:** $561-$1,033 MM **Taxes:** $10 MM	**Jobs:** 6,000–16,000 **Income:** $646 - $1,280 MM **Taxes:** $24 MM	**Jobs:** 9,300–12,100 **Income:** $831 - $1,057 MM **Taxes:** $51 MM
Operational Phase	**Jobs:** 500 **Income:** $13 - $36 MM **Taxes:** $5 MM	**Jobs:** 200 **Income:** $33 MM **Taxes:** $28 MM	**Jobs:** 100 **Income:** $7 - $8 MM **Taxes:** $21 MM

Diversity Benefits

- Interstate transmission allows utilities to diversify their portfolios of intermittent resources
- New Mexico, Colorado, and Arizona have policies to encourage in-state renewable development, increasing diversity with imports would bring benefits
  - Blending Wyoming wind with local wind resources in Colorado and New Mexico improves reliability and reduces issues with system intermittency
  - Blending out-of-state wind with local solar resources in Arizona results in a more diverse resource profile and reduces the risk of overreliance on a single technology

Diverse Wind Profiles



Ten Day Snapshot of Geographically Diverse Wind Profiles

Operational Issues Under High Renewable Penetration

- Colorado, New Mexico, and Arizona may face operational challenges as renewable penetration increases
- For example, as Colorado approaches its 30% RPS target
  - At low renewable penetrations, wind displaces gas generators, which are flexible enough to accommodate intermittency at the cost of increased O&M expenses
  - As Colorado continues to develop local wind resources, wind will eventually begin to displace baseload generators (coal), which cannot ramp quickly and are much less flexible than gas plants
  - This situation may result in wind curtailment, increasing the cost of RPS compliance
- HPX would allow the export of wind energy when operating conditions would otherwise require curtailment

Other Potential Benefits

Potential Benefit	Description
Deferral of Other T&D Investments for Reliability	Potential to avoid other costly investments in the transmission network necessary for reliability due to increased reliability resulting from HPX
Insurance and Risk Mitigation	High costs of extreme system contingencies may be avoided or mitigated by transmission expansion
Increased Market Liquidity	Lower buy-sell spreads at regional trading hubs resulting from increased proximity to Palo Verde
Potential Synergies with Other Transmission Projects	Installation of HPX could increase the benefits associated with other major transmission projects
Reductions in Fuel Demand and Prices	Potential for regional reductions in natural gas and coal prices due to lower demand resulting from improved dispatch efficiency (benefits extend outside the electricity industry)
Emissions Reductions	Regional reductions in CO2 and other emissions due to improved dispatch and reduced losses
Reduced Outage Likelihood	Reduced probability of costly power outages
Reduced Reliability-Related Operating Costs	Reductions in ancillary service procurement costs and other reliability-based operating costs due to increased system reliability

Source: The Brattle Group, *Transmission Investment Needs and Cost Allocation: New Challenges and Models*

Commercial Issues

- Who Pays?
  - Multiple jurisdictions
  - Benefits and are not equally distributed
  - Some benefits can not be easily monetized
  - Beneficiaries may have alternate plans
- Would it have its own tariff?
- Would participants have ownership in the entire path or certain sections?
- Can it be built in sections?
  - Are the same benefits realized?

Commercial Conclusions

- Single corridor configurations seem to be most cost effective
- Benefit/Cost ratios are generally > 1.0
- High level of uncertainty
  - Scenarios show wide range of outcomes
  - Public policy adds additional uncertainty
- There is no clear method for allocating and recovering costs
- Specific demand for HPX has not been identified
- Market drivers and public policy should be further monitored and studied

Questions or Comments?