



2015 INTEGRATED RESOURCE PLAN

IRPWG Meeting

Session 4

February 19, 2014

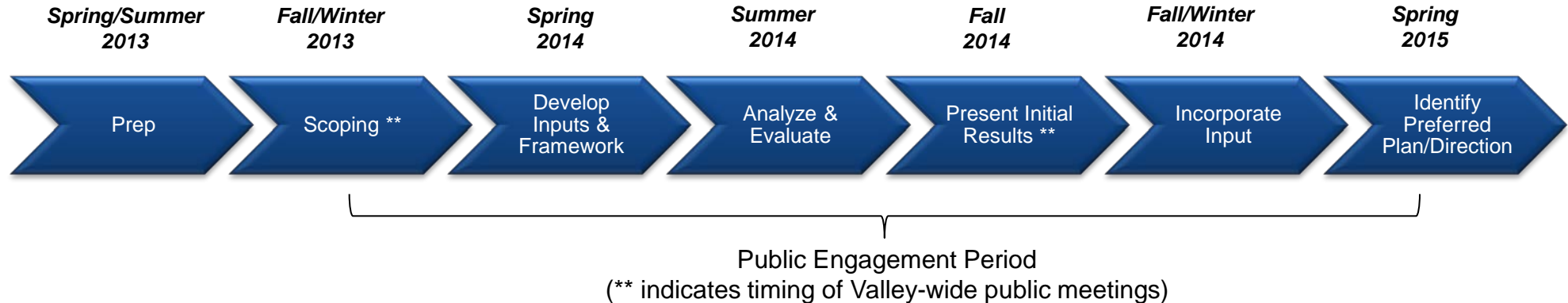


IRPWG Meeting – February Agenda

9:00	Welcome	Randy McAdams
9:15	General Updates	Joe Hoagland
9:30	IRP Methodology Overview	Randy McAdams
9:45	Scenarios Selected for the 2015 IRP	Gary Brinkworth
10:00	Strategy Design Process Overview	
	Introduction to Resource Options	
11:00	Break	
11:15	Attributes and Strategies Under Review by TVA for the 2015 IRP	Gary Brinkworth
12:00	Lunch	
12:30	Attributes and Strategies Under Review by TVA for the 2015 IRP (Cont.)	
1:45	Break	
3:30	IRP Benchmarking: Attributes and Strategies	Randy McAdams
3:45	Wrap-up	

2015 IRP Schedule: Major Project Phases and Milestones

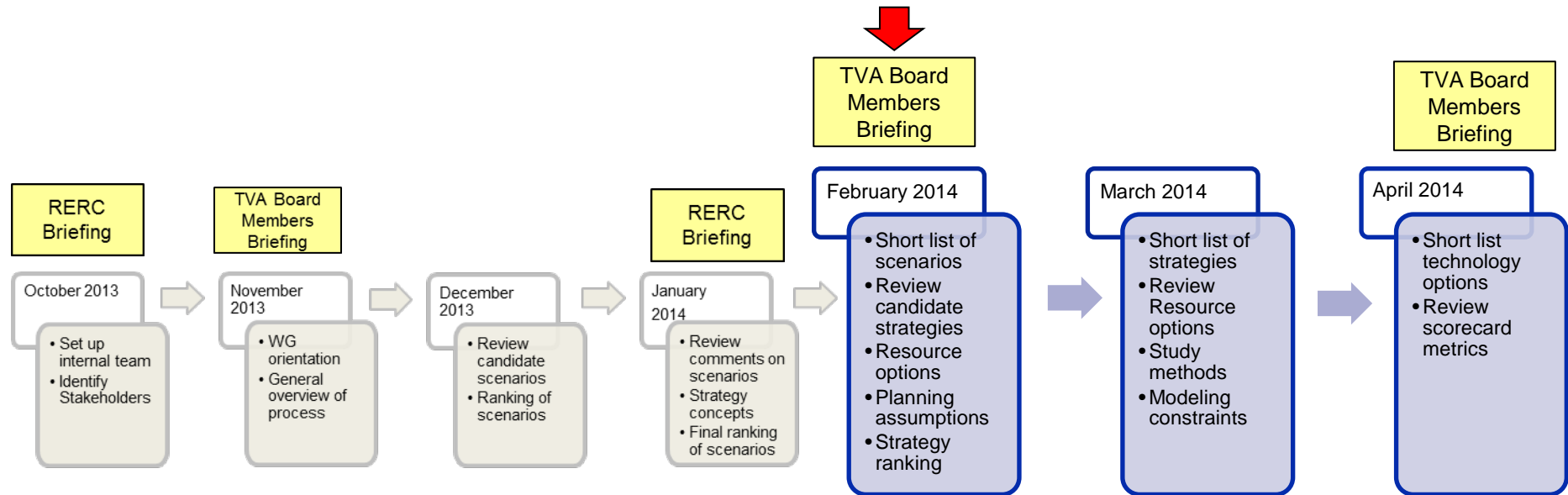
The 2015 IRP is intended to ensure transparency and enable stakeholder involvement.



Key tasks/milestones in this study timeline include:

- ◆ Establish stakeholder group and hold first meeting (Nov 2013)
- ◆ Complete first modeling runs (June 2014)
- ◆ Publish draft Supplemental Environmental Impact Statement (SEIS) and IRP (Nov 2014)
- ◆ Complete public meetings (Jan 2015)
- ◆ Final publication of SEIS and IRP and Board approval (exp. Spring 2015)

February 19th IRPWG Meeting Objectives



During today's meeting we aim to accomplish the following objectives:

- ◆ Present the final list of uncertainties and scenarios selected for the 2015 IRP
- ◆ Introduce resource options
- ◆ Explain the strategies under review by TVA
- ◆ Begin the discussion of planning assumptions
- ◆ Define the next step for the WG in order to rank and select the top five strategies for next session

In addition we will refresh some basic concepts of the IRP methodology



RERC Discussion Topics: January 22nd and 23rd

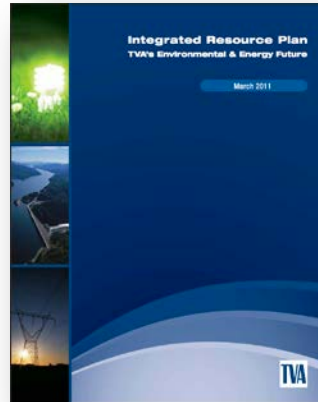
- ◆ Recap of the November Board meeting
- ◆ Discussion of how TVA balances specific resource decisions with the IRP
- ◆ An update on the IRP: Status of the scenarios
- ◆ Rates: Key Financial Considerations
- ◆ Reliability: Reliability and Resiliency Considerations
- ◆ Responsibility: Environmental Stewardship considerations
- ◆ Public Comment Period
- ◆ Development of Council Advice

TVA IRP Context in Asset Decisions

Planning Strategies	Current Situation	Scenarios				
		#1	#2	#3	#4	#5
Planning Strategy A						
Planning Strategy B						
Planning Strategy C						
Planning Strategy D						
Planning Strategy E						

Other Strategic Considerations

Internal/External Stakeholder Input



Financial Health Rates

Reliability Resiliency

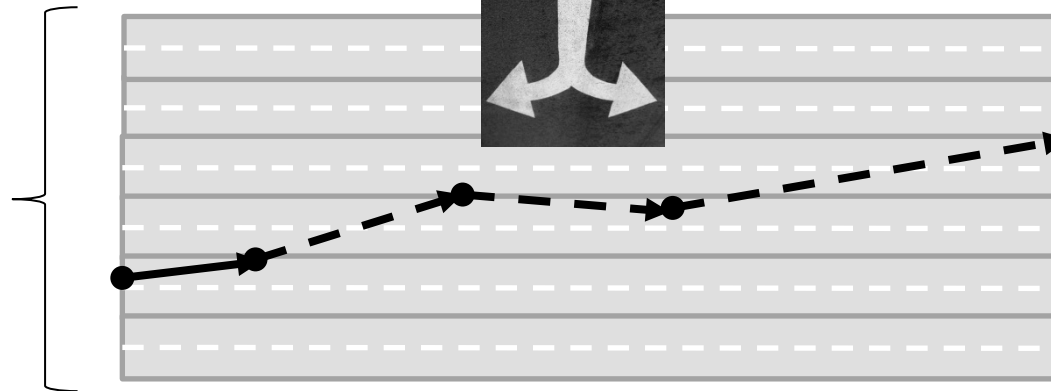
Environmental Stewardship



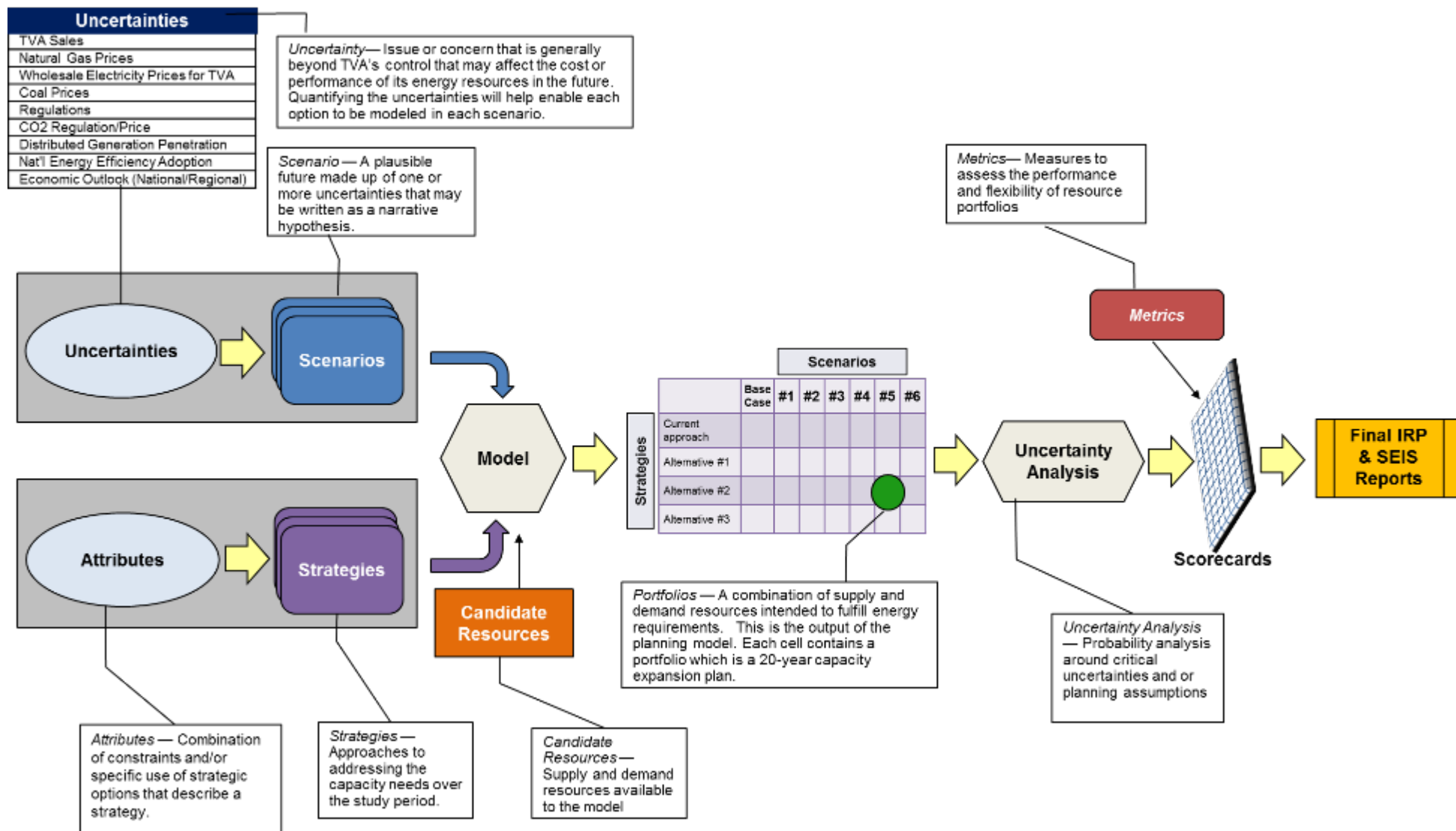
**Note:
Discussed
with RERC**

**IRP establishes
direction for
'The Highway'**

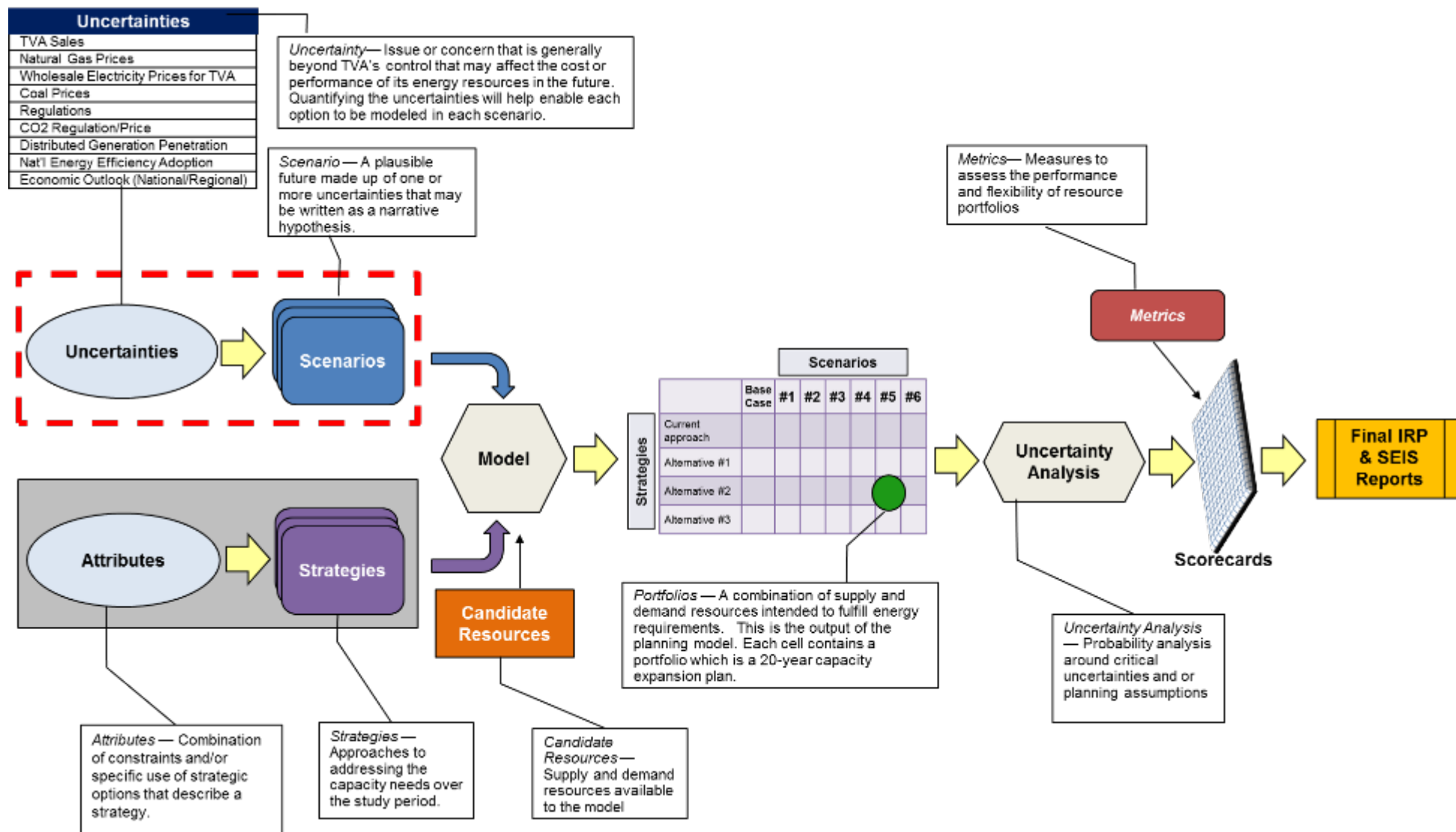
**Specific 'Lane' decided
by TVA Leadership with
Business Considerations**



IRP Methodology and Glossary



IRP Methodology: Uncertainties and Scenarios



IRPWG Feedback on the Scenario Ranking Results

At the January 13th IRPWG meeting, stakeholders made several recommendations about the scenarios after reviewing and discussing the initial ranking results

- ◆ There was a desire for fewer and perhaps more distinct scenarios
- ◆ It seems that DE1 is a really just a sensitivity test of the current outlook because the only uncertainty that changes in that future is TVA sales; can this be eliminated as a scenario and tested as a sensitivity instead?
- ◆ A suggestion was made that perhaps two of the first round top 5 scenarios, SE1 and DE3, might be combined due to minimal apparent differences
- ◆ Should the current outlook be treated with the same rigor as the other scenarios we are considering (that is, why is it not being included in the proposed short list)?
- ◆ It appears that to correct a bias in the initial ranking a growth scenario should be added to the list; consensus seemed to favor EG1
- ◆ And finally, if these general suggestions were implemented by TVA the stakeholders did not see the need for a second ranking exercise

TVA agreed that revisions to the scenario short list were needed to ensure a robust IRP



TVA's Response to These Recommendations

- ◆ TVA eliminated DE1 – we can test the change in sales in a sensitivity case (it will also be tested in the probability/stochastics)
- ◆ TVA eliminated DE3 and retained SE1 because we feel that scenario is more important, and allows us to consider a future that is defined by stringent environmental regulations
- ◆ Those decisions reduced the number of scenarios retained from the initial ranking exercise to three
 - *Customer-Driven Competitive Resources (CP1)*
 - *De-carbonized Energy Future (SE1)*
 - *Prolonged Stagnant National Economy (DE2)*
- ◆ Scenario EG1 was added to improve the balance among the scenarios and create a broader set of plausible futures to be studied
- ◆ TVA decided to include the current outlook as a formal scenario

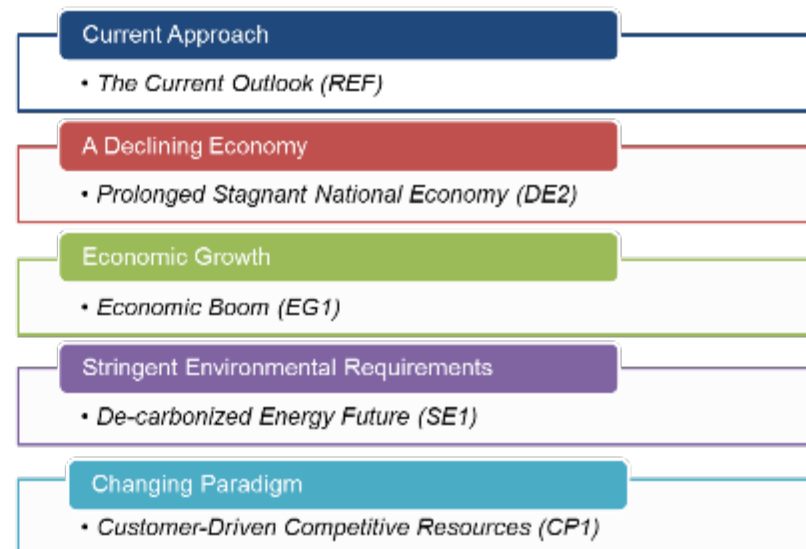
Uncertainties and Scenarios selected for the 2015 IRP

TVA has selected 9 uncertainties and 5 scenarios grouped around 5 themes

Selected Uncertainties

Uncertainty	Description
TVA Sales	◆ The customer energy requirements (GWh) for the TVA service territory including losses; it represents the load to be served by TVA
Natural Gas Prices	◆ The price (\$/MMBtu) of the commodity including transportation
Wholesale Electricity Prices for TVA	◆ The hourly price of energy (\$/MWh) at the TVA boundary; used as a proxy for market price of power
Coal Prices	◆ The price (\$/MMBtu) of the commodity including transportation
Regulations	◆ All regulatory and legislative actions, including applicable codes and standards, that impact the operation of electric utilities excluding CO2 regulations
CO2 Regulation/Price	◆ The cost of compliance with possible CO2 related regulation and/or the price of cap-and-trade legislation, represented as a \$/Ton value
Distributed Generation Penetration	◆ National trending of distributed generation resources and potential regional activity by customers or third party developers (not TVA)
Nat'l Energy Efficiency Adoption	◆ An estimate of the adoption of energy efficiency measures by customers nationally; a measure of interest/commitment of customers in general to adopt EE initiatives, recognizing the impacts of both technology affordability and electricity price on willingness to adopt efficiency measures
Economic Outlook (National/Regional)	◆ All aspects of the regional and national economy including general inflation, financing considerations, population growth, GDP and other factors that drive the overall economy

Selected Scenarios



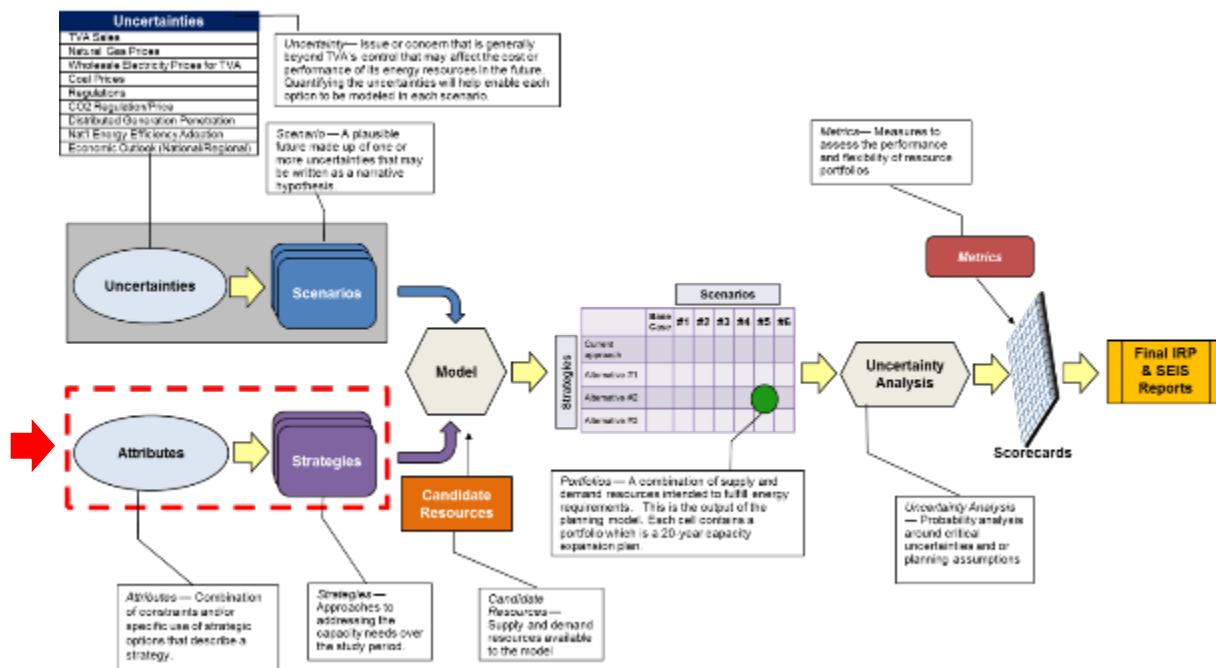
The Scenarios Selected Provide a Good Diversity of Possible Futures

Scenarios Selected for the 2015 IRP

	The Current Outlook (REF)	Prolonged Stagnant National Economy (DE2)	Economic Boom (EG1)	De-carbonized Energy Future (SE1)	Customer Driven Competitive Resources (CP1)
TVA Sales	Same	Very Low	High	Low	Low
Natural Gas Prices	Same	Low	High	High	Low
Wholesale Electricity Prices to TVA	Same	Low	High	High	Low
Coal Prices	Same	Low	High	Same	Low
Regulations	Same	Low	High	Same	Same
CO2 Regulation/Price	Same	Very Low	High	Very High	Same
Distributed Generation Penetration	Same	Low	High	High	Very High
Nat'l Energy Efficiency Adoption	Same	Low	High	High	Very High
Economic Outlook (National/Regional)	Same	Very Low	High	Low	Same

Defining Planning Strategies Is the next Step in Establishing the Planning Framework

IRP Methodology: Strategies and Attributes



A well-designed strategy will perform well in many possible scenarios

Planning Strategies

- ◆ The strategies are designed to test various business options on how to address capacity needs over the study period
- ◆ Whereas, scenarios describe plausible futures and include factors that TVA cannot control, strategies describe business decisions over which TVA has full control
- ◆ Planning strategies are defined by a combination of resource assumptions and constraints (Attributes) such as:
 - EEDR portfolio
 - Nuclear expansion
 - Energy storage usage
- ◆ Strategies consider multiple viewpoints
 - Public scoping period comments
 - Assumptions that would have the greatest impact on TVA long-term

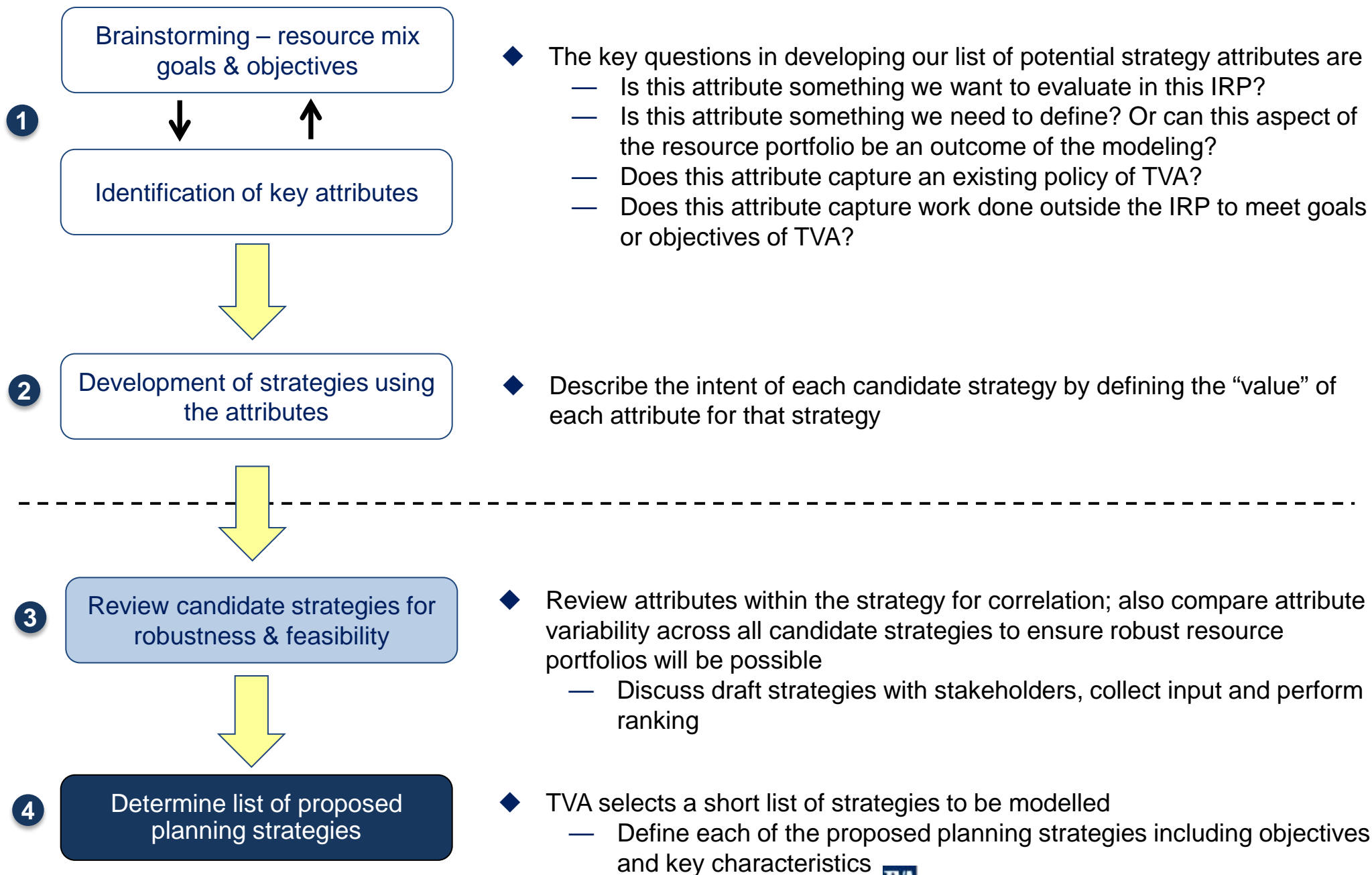
What are the Attributes of a Planning Strategy?

Attributes = Solution Boundaries



- ◆ The attributes of a planning strategy define the “solution space” within which the model will seek an optimized resource plan - they define the sides (and size) of the box
- ◆ These boundaries either represent modeling constraints – i.e. how many CT/CC units we could add in any one year - or they represent a goal/preference on TVA's part that we want to be sure ends up in the resource plan – i.e. a minimum level of EEDR to reflect commitments to the EPA
- ◆ Boundaries can be firm/fixed or they can be min/max restrictions; they can also be in the form of pre-defined options that will be chosen but not optimized by the model – the EEDR portfolios in the 2011 IRP study are an example of this type of attribute
- ◆ Attributes are set by TVA and then shared with the stakeholders to help them understand and interpret the outcome of the modeling exercise

TVA's Process for Building Strategies



IRP Strategy Attributes: 2015 vs. 2011

- ◆ In the 2011 IRP, some strategy attributes were developed outside of the optimization process and were consider “fixed” parts of the portfolio
- ◆ In the 2015 study, we intend for all attributes to be selected dynamically as part of the capacity optimization modeling

Attributes from the 2011 IRP Study	Description
EEDR portfolio	A level of energy efficiency (EE) and demand response (DR) included in each strategy
Renewable Additions	An amount of renewable resources added in each strategy
Fossil Asset Strategy	A proposed schedule of coal unit idling that will be tested in each strategy
Energy Storage	Option to include a pumped-storage hydro unit in selected strategies
Nuclear Expansion	Constraints related to the addition of new nuclear capacity
Coal Technology	Limitations on technology and timing on new coal-fired plants
Gas-Fired Supply (self build)	Limitations on gas-fired unit expansion
Market Purchases	Level of market reliance allowed in each strategy
Transmission	Type and level of transmission infrastructure required to support resource options in each strategy

These attributes were scheduled or predetermined. This applied to both the timing and quantity of specific asset decisions

These attributes constrained the optimization of asset choices such as minimum build times, technology limitations and other strategic constraints including limits on market purchases. The capacity optimization model selected resources that were consistent with these constraints

 “Fixed” parts of the portfolio

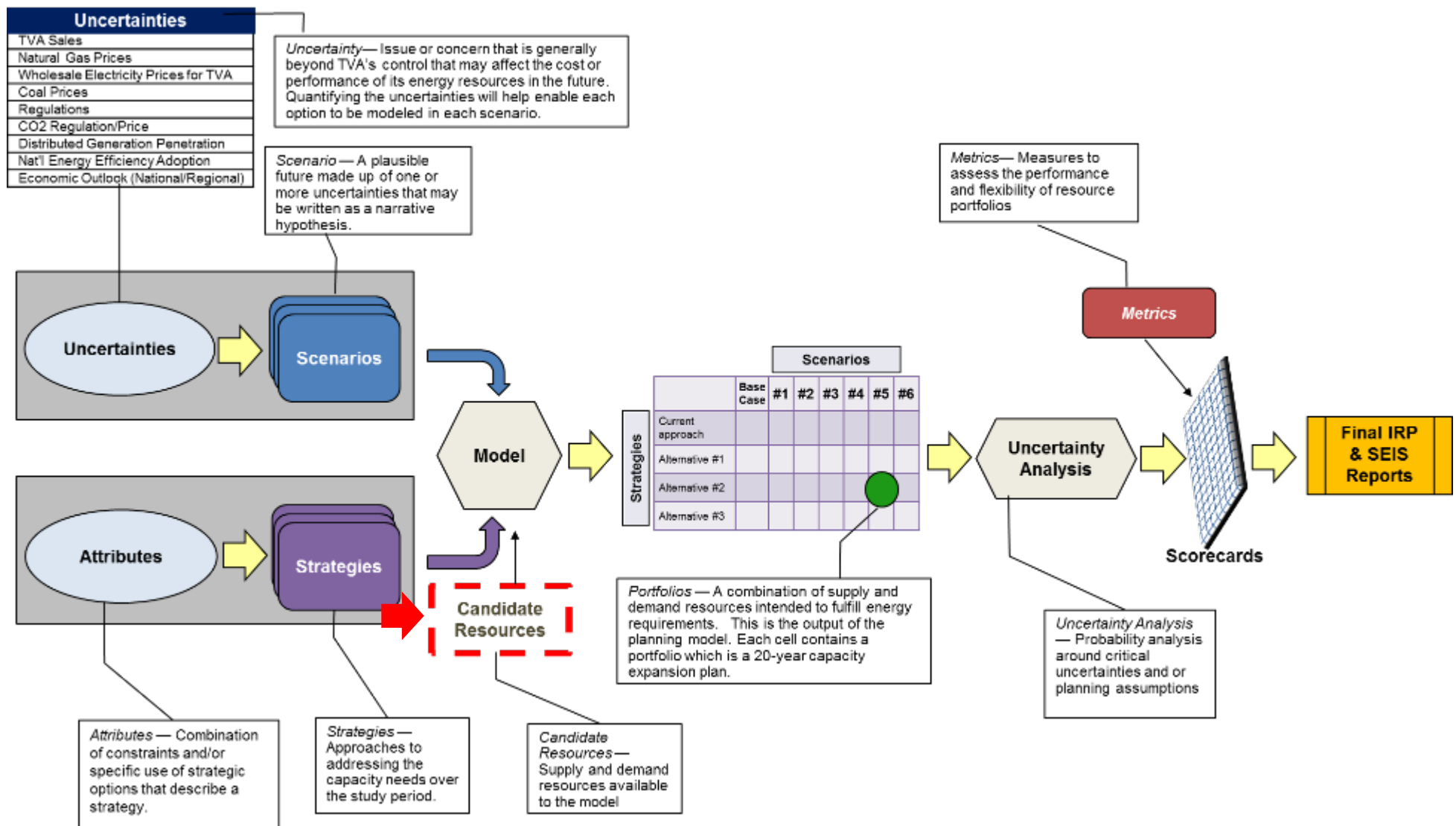
For more information of the 2011 IRP’s Strategy Attributes please refer to Chapter 6 of the 2011 IRP document

2011 IRP Planning Strategy Summaries

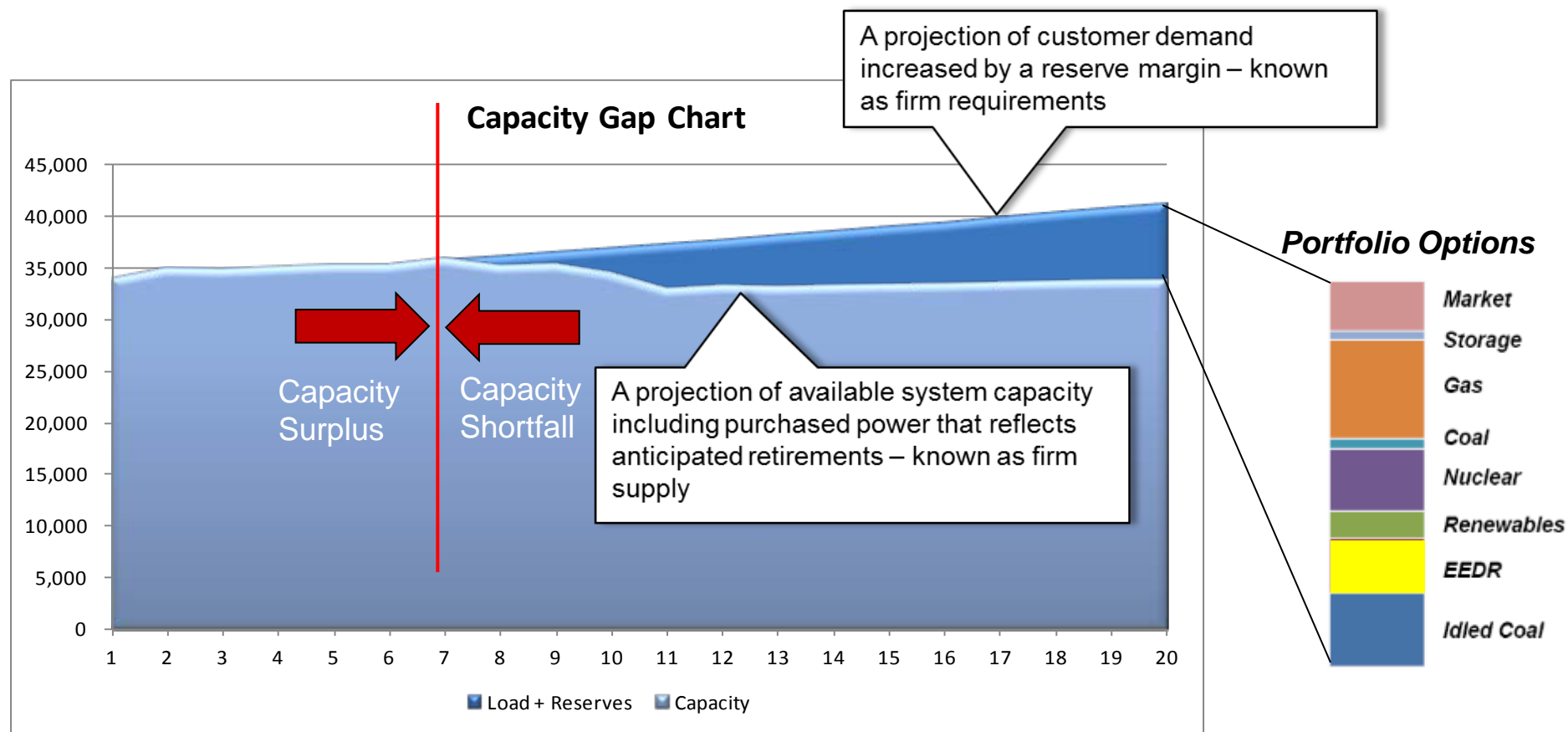
Planning Strategy	Key Characteristics
A – Limited Change in Current Resource Portfolio	<ul style="list-style-type: none"> — Retain and maintain existing generating fleet (no additions beyond Watts Bar 2) — Rely on the market to meet future resource needs
B – Baseline Plan Resource Portfolio	<ul style="list-style-type: none"> — Allows for nuclear expansion after 2018 and new gas-fired capacity as needed — Assumes idling of 2,000 MW of coal capacity — Includes EE/DR portfolios and wind PPA's
C – Diversity Focused Resource Portfolio	<ul style="list-style-type: none"> — Allows for nuclear expansion after 2018 and new gas-fired capacity as needed — Increases the contribution from EE/DR portfolio and new renewables — Adds a pumped storage hydro unit — Assumes idling of 3,000 MW of coal capacity
D – Nuclear Focused Resource Portfolio	<ul style="list-style-type: none"> — Allows for nuclear expansion after 2018 and new gas-fired capacity as needed — Includes an increased EE/DR portfolio compared to other strategies — Assumes idling of 7,000 MW of coal capacity — Includes new renewables (same as planning strategy C) — Includes a pumped storage hydro unit
E – EE/DR and Renewables Focused Resource Portfolio	<ul style="list-style-type: none"> — Assumes greatest reliance on EE/DR portfolio of any strategy and includes largest new renewable portfolio — Assumes idling of 5,000 MW of coal capacity — Delays nuclear expansion until 2022

A detailed description of the values of the attributes for these strategies is included in Appendix A

IRP Methodology: Candidate Resources



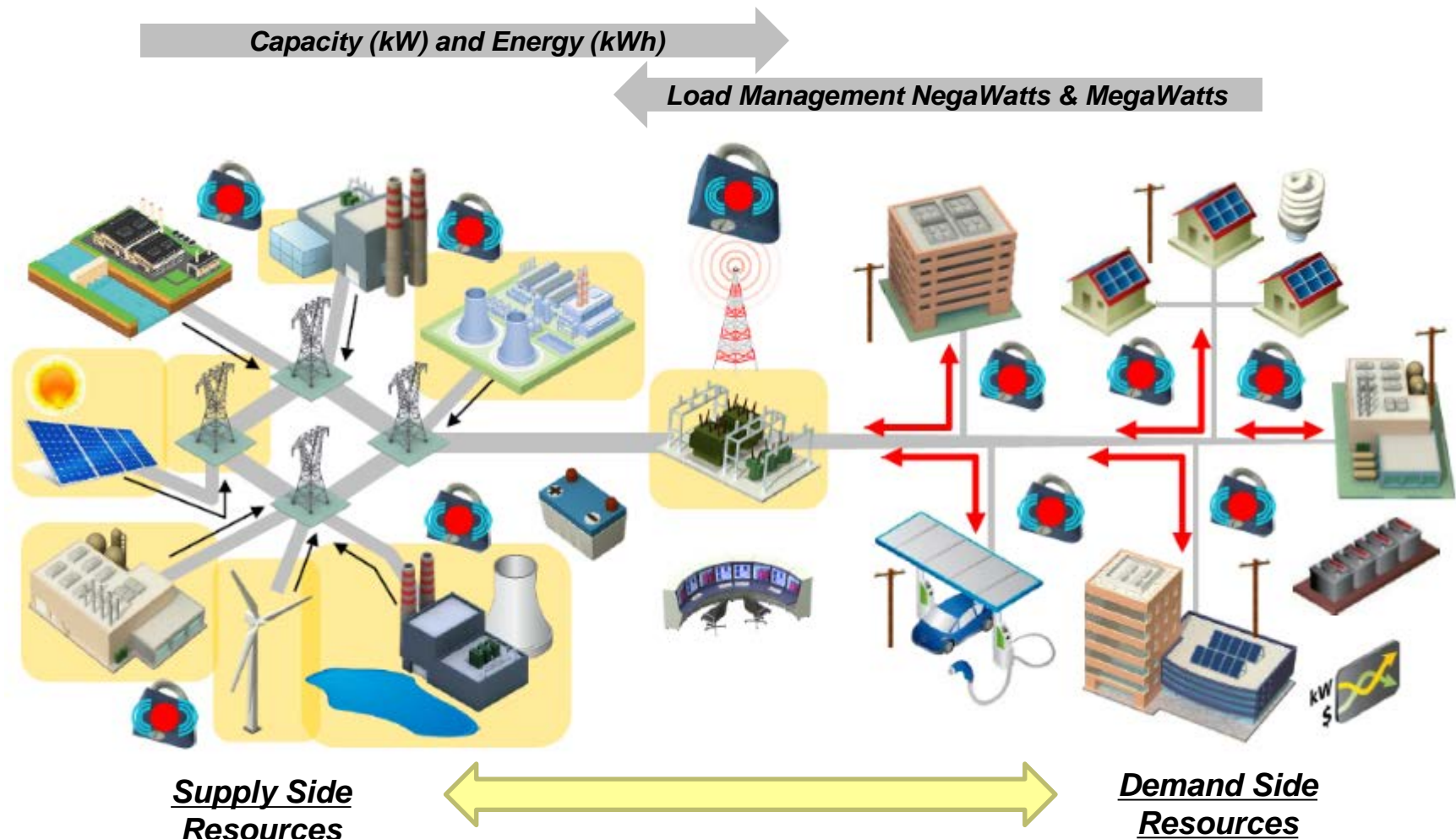
The Objective of the IRP is To Find the Optimum Mix and Timing of Resources



Recommended path includes the capacity mix that provides low cost, diversity and flexibility over the planning horizon

TVA Operates in a Multidirectional Energy Environment

TVA operates in an environment in which renewables, energy efficiency (EE), distributed generation, and demand response (DR) are managed by multiple entities



A Wide Variety of Both Supply-Side and Demand-Side Candidate Resources Are Considered for the IRP

Candidate Resources Categories



Conventional Power Plants

- Nuclear, coal and gas
- Screened based on feasibility, technology maturity, and leveled (busbar) cost by type and duty cycle



Renewable resources

- Hydro, wind, solar, biomass and storage resources
- Screened based on feasibility, technology maturity, and leveled (busbar) cost by type and duty cycle



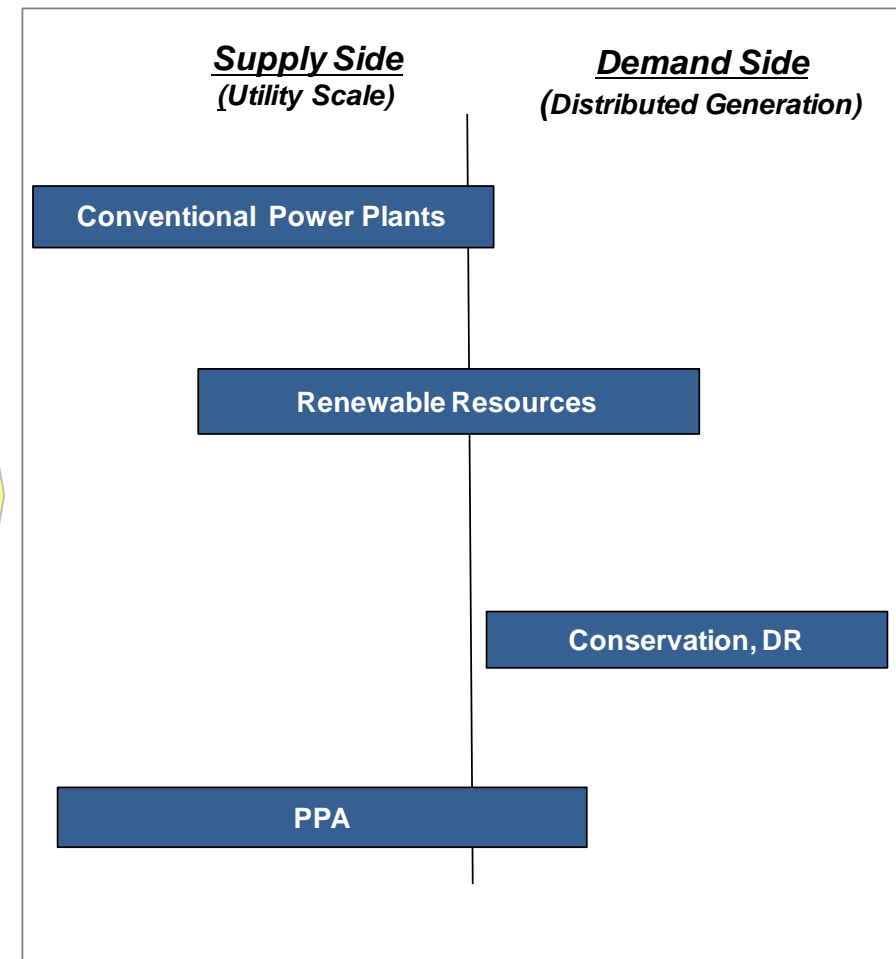
Conservation, Demand Management (DR)

- Energy Efficiency and Demand Response Programs



Purchase Power Agreement (PPA)

- Reflects proposals submitted to TVA, from resources of any kind, inside and outside the Valley
- Includes transmission costs and limitations if applicable
- Excludes generic market purchases

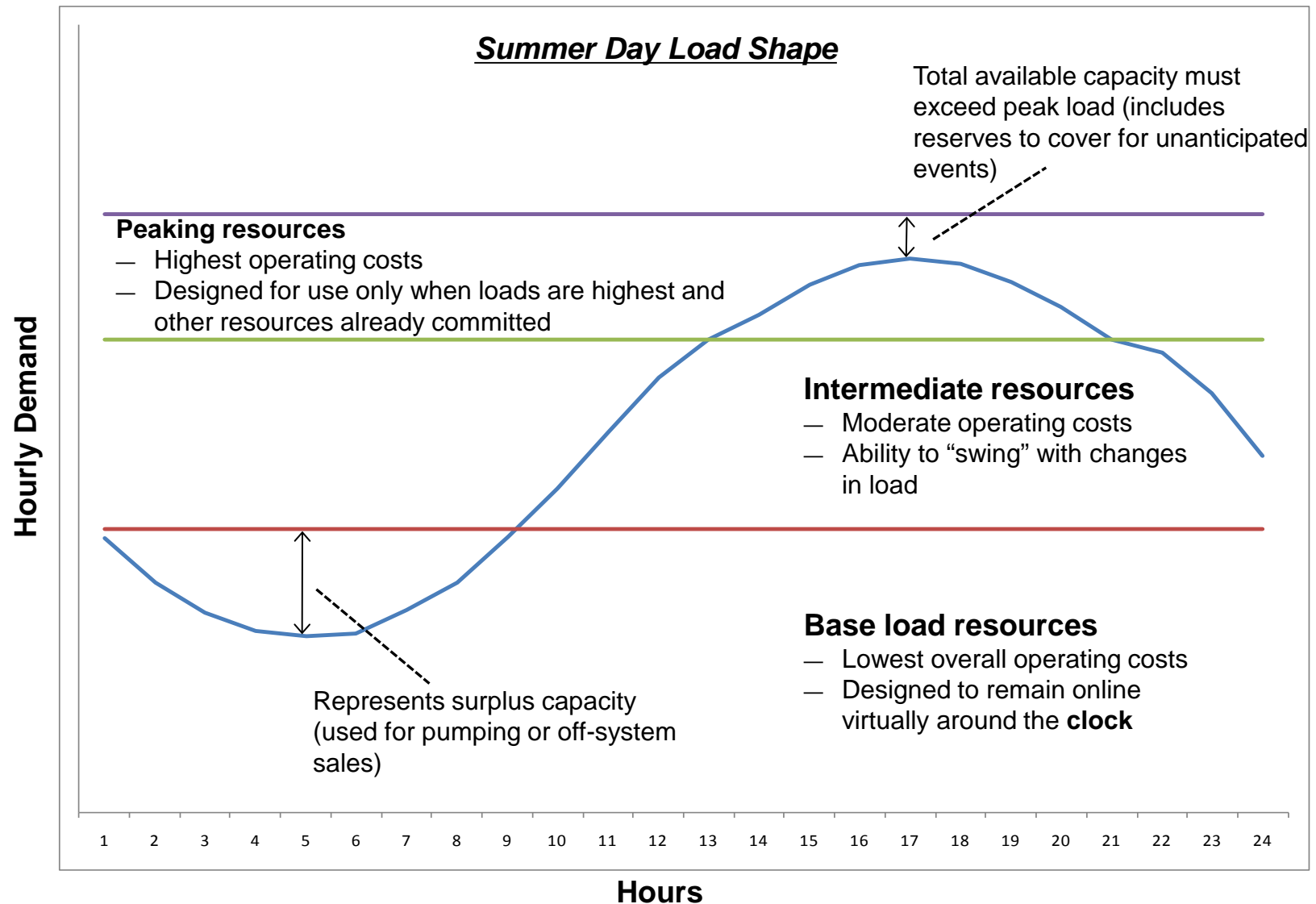


Resource options are screened based on multiple criteria:

- ◆ Policy considerations
- ◆ Technological viability and maturity
- ◆ Economic (based on levelized cost)

Resources Have Different Operational Characteristics






The final mix of resources need to be balanced across their operational characteristics to effectively manage cost





TVA Has a Balanced Generation Mix Able To Address These Operational Requirements

TVA's Current Generation Fleet

 Hydro	<u>Plants/Units</u>	<u>First/Last in Service</u>	<u>Capacity MW*</u>
	30	1912/1979	5,433
 Coal	10	1951/1973	12,901
 Nuclear	3 / 6	1974/1996	6,710
 Gas CT/CC	14	1971/2012	9,242
 Other	Contractual/Purchases, Diesels, and Renewables		2,295

* Summer Net Capability

Capacity values in this table are consistent with the 2013 10-k report

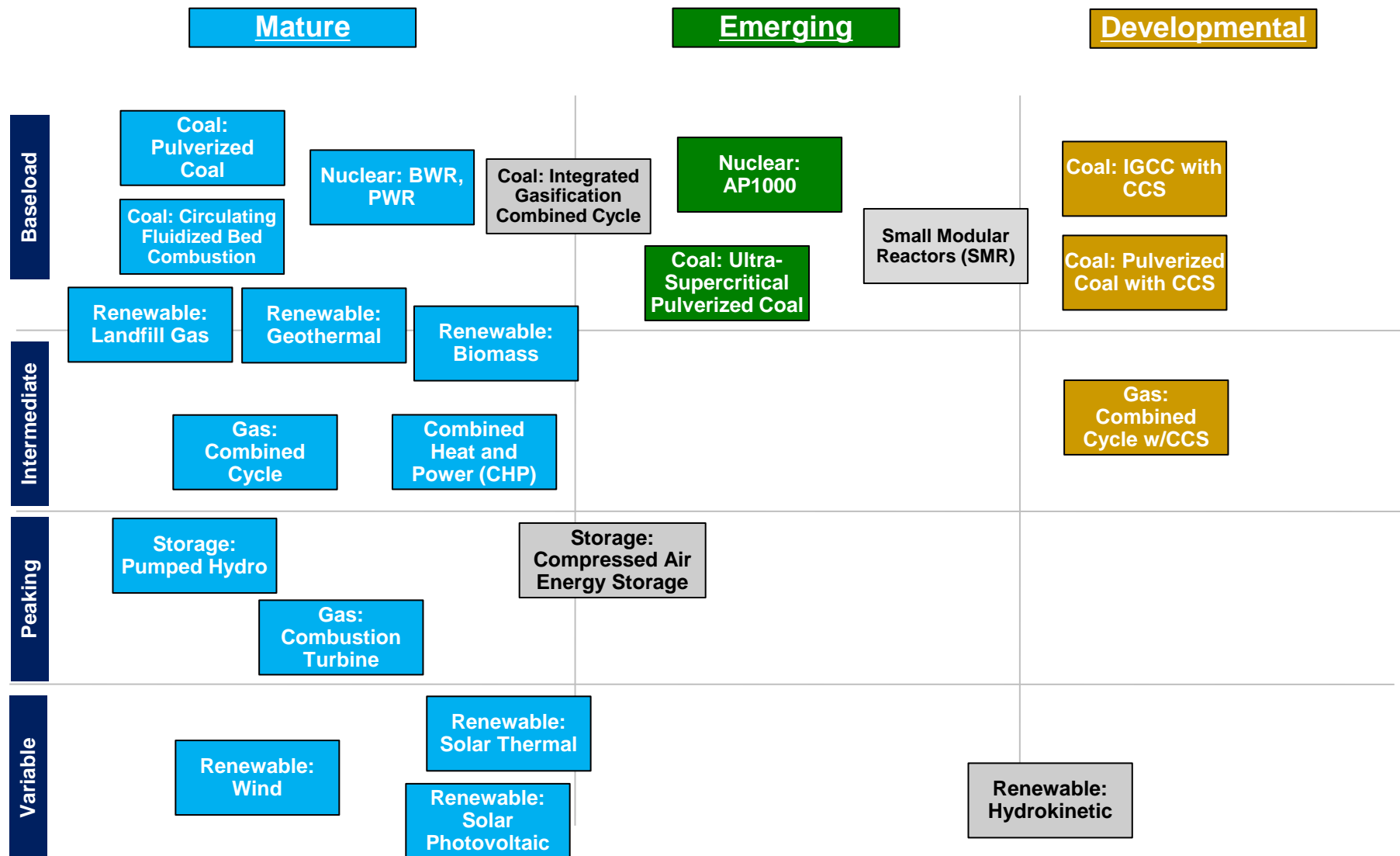


Preliminary List of Resources Being Considered for the 2015 IRP

Conventional	Renewables/Storage	Conservation/DR	PPA
Units available for selection			
<p>Coal</p> <ul style="list-style-type: none"> Supercritical Pulverized Coal 800 or 1600 MW Supercritical Pulverized Coal with CCS 800 or 1600 MW IGCC 561 MW IGCC with CCS 467 MW Circulating fluidized bed 750 MW Ultra Supercritical Pulverized Coal 750 MW <p>Nuclear</p> <ul style="list-style-type: none"> Nuclear AP1000 1117 MW Small Modular Reactors 334 MW Bellefonte Units 1&2 (B&W design) 1260 MW each Electric Power Upgrades MW as identified per project <p>Gas</p> <ul style="list-style-type: none"> Combustion Turbine (3x) 590 MW Combustion Turbine (4x) 786 Combined Cycle (2 on 1) 768 Combined Cycle (3 on 1) 1152 	<p>Storage</p> <ul style="list-style-type: none"> Pumped Storage 850 MW CAES 330 MW <div>Additional resource options in these categories are likely pending the completion of work currently underway in information exchange groups (TVRIX, EEIX)</div>		<ul style="list-style-type: none"> Options are based on proposals submitted to TVA from resources inside and outside the Valley and are usually tied to a specific project for a defined term at a negotiated price Transmission costs and import limitations are included in the PPA characteristics, if applicable PPA's are not screened <ul style="list-style-type: none"> They are included in the database as proposed The model treats these PPA's as a fixed transaction that can only be selected based on terms defined in the offer PPA's cannot be rescheduled or selected in amounts that do not conform to the proposal TVA is currently evaluating six to eight PPA's that could be chosen as part of the least cost resource plan
Fixed or Scheduled Assets			
<ul style="list-style-type: none"> Existing Coal Existing Nuclear Existing gas fleet 	<ul style="list-style-type: none"> Existing hydro Existing pumped storage Existing Hydro PPAs Existing Renewable PPAs (Wind, RSO, SSI, LFG, etc) End use generation programs Existing solar 	<ul style="list-style-type: none"> EEDR programs Interruptible programs In-house interruptible programs 	<ul style="list-style-type: none"> Existing PPAs (Red Hills, diesels, etc)

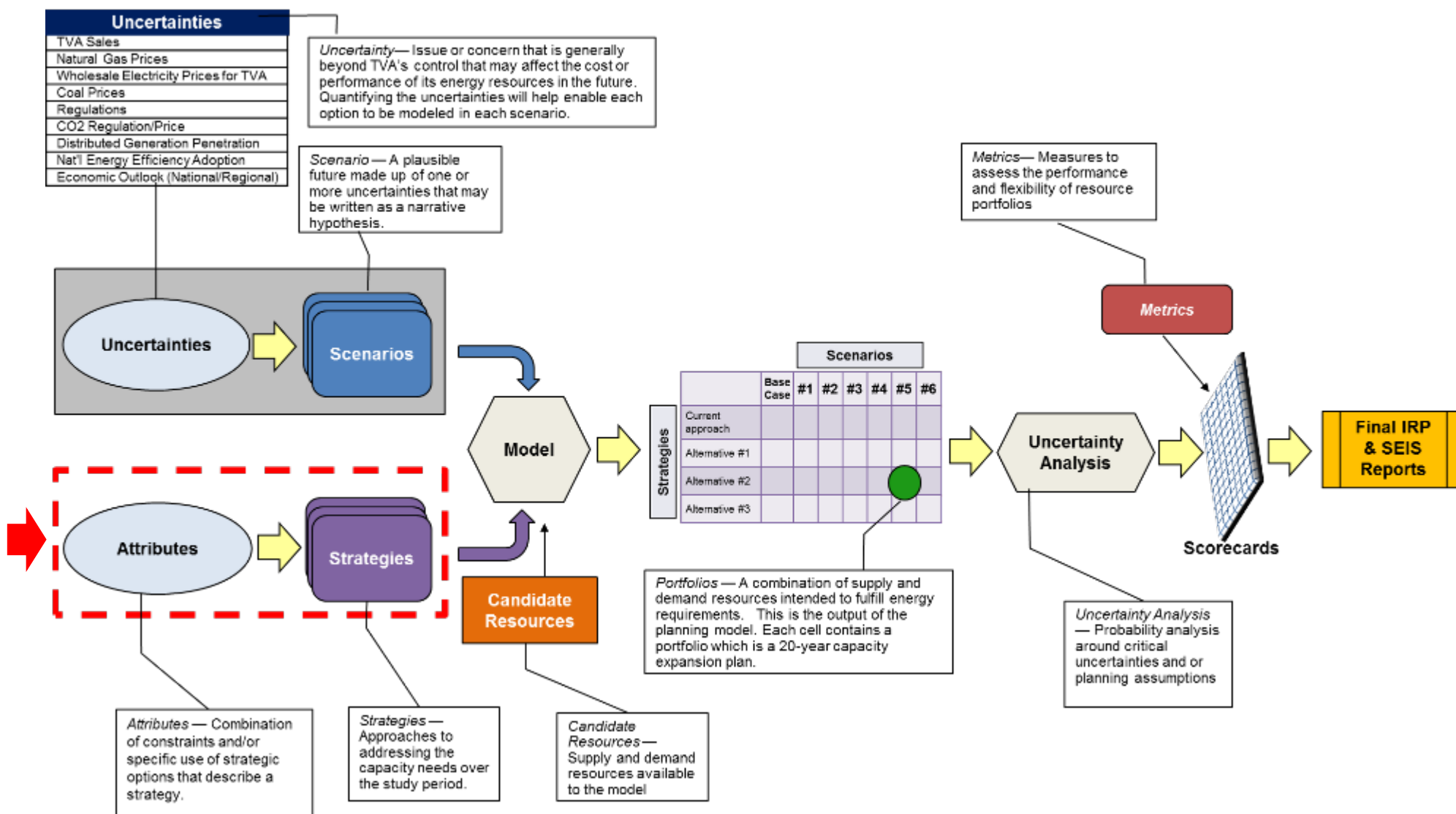
Evaluating Technology Maturity is Part of Sound Resource Planning

Preliminary tabulation of resources by duty cycle and maturity

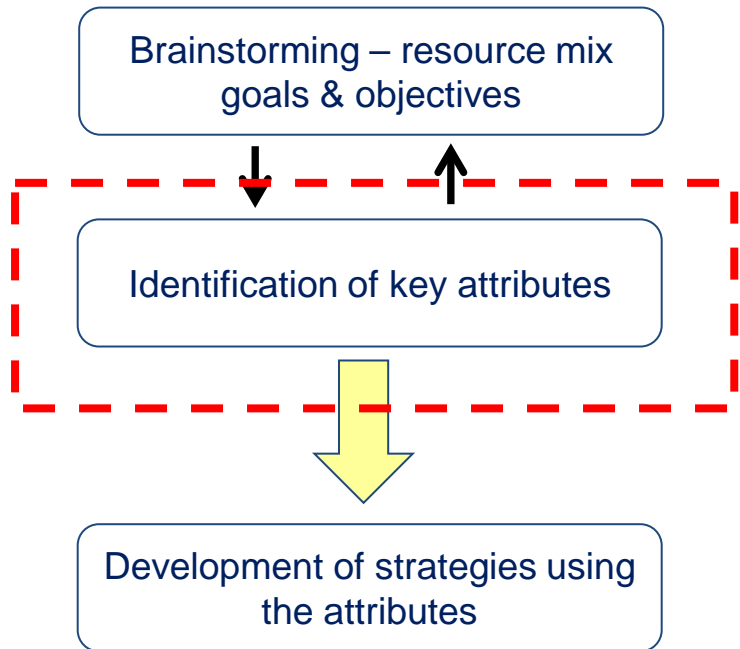


Technologies in transition

IRP Methodology: Strategies and Attributes



Selecting Potential Attributes



The key questions in developing our list of potential strategy attributes are:

- ◆ Is this attribute something we want to evaluate in this IRP?
- ◆ Is this attribute something we need to define? Or can this aspect of the resource portfolio be an outcome of the modeling?
- ◆ Does this attribute capture an existing policy of TVA?
- ◆ Does this attribute capture work done outside the IRP to meet goals or objectives of TVA?

TVA Has Defined 10 Attributes

Attributes	Description
Existing Nuclear	Constraints related to the existing nuclear fleet; EPU's are considered part of existing nuclear
Nuclear Additions	Limitations on technologies and timing related to the addition of new nuclear capacity; Watts Bar 2, SMRs, A/P 1000s and BLN are considered in this category
Existing Coal	Constraints related to the existing coal fleet; the current schedule plan of coal unit idling is considered as an input
New Coal	Limitations on technology and timing on new coal-fired plants; includes CCS on conventional coal plus IGCC technology
Gas Additions	Limitations on technologies and timing related to the expansion options fueled by natural gas (CT, CC)
EEDR	Considers energy efficiency and demand response programs that are incentivized by TVA and/or LPC's (excludes impacts from naturally occurring efficiency/ conservation)
Renewables (Utility Scale)	Limitations on technologies and timing of renewable resources; considers options that would be pursued by TVA or in collaboration with LPC's
Purchased Power Agreements (PPA)	Level of market reliance allowed in each strategy; no limitation on the type of energy source (conventional or renewable)
DG/DER	Includes customer-driven resource options or third party projects that are distributed in nature
Transmission	Type and level of transmission infrastructure required to support resource options in each strategy

IRP Strategy Attributes: 2015 vs. 2011

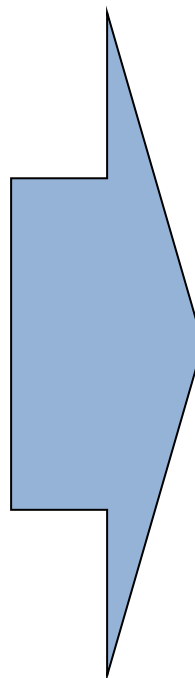
Attributes from the 2011 IRP Study	Attributes for the 2015 IRP Study
	Existing Nuclear
Nuclear Expansion	Nuclear Additions
Fossil Asset Strategy	Existing Coal
Coal Technology	New Coal
Gas-Fired Supply (self build)	Gas Additions
EDDR portfolio	EEDR
Renewable Additions	Renewables (Utility Scale)
Market Purchases	Purchased Power Agreements (PPA)
Energy Storage	
	DG/DER
Transmission	Transmission

■ “Fixed” parts of the portfolio

Developing the Planning Strategies

Design Guide: Planning Strategies

- ◆ The strategies are designed to test various business options on how to address capacity needs over the study period
- ◆ Whereas, scenarios describe plausible futures and include factors that TVA cannot control, strategies describe business decisions over which TVA has full control
- ◆ Planning strategies are defined by a combination of resource assumptions and constraints (Attributes) such as:
 - EEDR portfolio
 - Nuclear expansion
 - Energy storage usage
- ◆ Strategies consider multiple viewpoints
 - Public scoping period comments
 - Assumptions that would have the greatest impact on TVA long-term



	Candidate Planning Strategies
A	"Traditional" Least Cost Planning
B	Meet an Emission Target
C	Lean on the Market
D	Do Gas Only
E	Doing More EEDR
F	Promoting Renewables
G	Energy-Water Nexus
H	No Nuclear

TVA is Considering Eight Strategies

STRATEGY	DESCRIPTION
A - “Traditional” Least Cost Planning	<ul style="list-style-type: none"> • All resource options available for selection; traditional utility “least cost optimization” case
B- Meet an Emission Target	<ul style="list-style-type: none"> • Resources selected to create lower emitting portfolio instead of focusing only on a traditional least cost approach • This lower emissions plan will be based on an emission rate target or level using CO₂ as the emissions metric (the target will be set as a reduction from current emissions forecast) • Additional existing unit retirements may be included in the plan.
C - Lean on the Market	<ul style="list-style-type: none"> • Most new capacity needs are met using market resources and/or third-party assets acquired through PPA or other bilateral arrangements • TVA makes a minimal investment in owned assets (deployment of EEDR to meet resource needs will continue)
D – Do Gas Only	<ul style="list-style-type: none"> • Allows only gas-fired resource expansion after WBN2 unit comes online. Allowed EEDR contribution based only on EPA requirements
E - Doing More EEDR	<ul style="list-style-type: none"> • In order to establish TVA as a regional energy efficiency leader, a majority of capacity needs are met by setting an annual energy target for EEDR (e.g., minimum contribution of 1% of sales) • Renewable energy and gas are secondary options with no coal or nuclear additions permitted

TVA is Considering Eight Strategies (Cont'd)

STRATEGY	DESCRIPTION
F - Promoting Renewables	<ul style="list-style-type: none"> • In order to establish TVA as a regional renewable leader, a majority of new capacity needs are met by setting immediate and long-term renewable energy targets (e.g., 20% by 2020 and 35% by 2040), including hydroelectric energy • A utility-scale approach is targeted initially with growing transition to distributed generation as the dominant renewable resource type by 2024 • EEDR and gas are secondary options with no coal or nuclear additions permitted
G - Energy-Water Nexus	<ul style="list-style-type: none"> • Reducing water use becomes a higher priority in resource planning • Mitigate energy resource risk due to water dependence and promote integrated resource stewardship by restricting energy resource and cooling system technologies to options with lower water impacts with preference for air-cooled methods • Additionally, preferentially target energy efficiency efforts in local water treatment infrastructure
H - No Nuclear	<ul style="list-style-type: none"> • Pursue an orderly, but prompt, shutdown of the current nuclear fleet • WBN2 allowed to go commercial as part of a bridging strategy to facilitate early shutdown of older nuclear units • Development work is terminated at BLN

Attributes and Strategies under review by TVA for the 2015 IRP

The Strategies Can Be Classified in 3 Categories

The proposed strategies can be classified in three categories according the approach in the use of some of the candidate resources:

- ◆ “Promoting” Strategy (P): Contains attributes that incentivize the use of a particular resource/s
- ◆ “Constraining” Strategy (C): Contains attributes that limit the use of a particular resource/s
- ◆ “Excluding” Strategy (E): One or more of the resources can not be used for expanding capacity

STRATEGY	Type	Comment
A - “Traditional” Least Cost Planning	C	No preference for any resource; the constraint is the aim of “minimum cost”
B- Meet an Emission Target	C	Promotes the use on no/lower CO2 emitting new resources by constraining the total emission of the generation portfolio
C - Lean on the Market	C	Preference new generation capacity not built by TVA
D – Do Gas Only	E	Excludes all options not fueled by NG for new capacity
E - Doing More EEDR	P	Promotes more EEDR by setting targets
F - Promoting Renewables	P	Promotes renewable resources through targets and cost trends of key technologies
G - Energy-Water Nexus	C	Promotes the use on no/low water use new resources by constraining the consumption of the generation portfolio
H - No Nuclear	E	Excludes any nuclear, including the current fleet

Strategy A – “Traditional” Least Cost Planning

Description:

All resource options available for selection; traditional utility “least cost optimization” case

Attributes	Comments
Existing Nuclear	Retain existing units through the end of the study window; uprates allowed
Nuclear Additions	Complete WBN2. Allow for new nuclear to be started after 2022 including BLN, SMRs and AP1000
Existing Coal	Based on current fleet strategy
New Coal	New coal allowed with CCS
Gas Additions	Expansion option allowed
EEDR	Ensure a minimum level of EEDR plus additional amounts as part of the least cost plan
Renewables (Utility Scale)	Expansion option allowed
Purchased Power Agreements (PPA)	Expansion option allowed
DG/DER	At minimum current renewable programs base case assumptions but allow expansion
Transmission	HV (161-kV) upgrades for coal idling and new resources, with the exception that new ties for increased renewables might require additional EHV (500 kV) or HVDC ties

Description:

- Resources selected to create lower emitting portfolio instead of focusing only on a traditional least cost approach
- This lower emissions plan will be based on an emission rate target or level using CO₂ as the emissions metric (the target will be set as a reduction from current emissions forecast)
- Additional existing unit retirements may be included in the plan

Attributes	Comments
Existing Nuclear	Retain existing units through the end of the study window; uprates allowed
Nuclear Additions	Complete WBN2. Allow for new nuclear to be started after 2022 including BLN, SMRs and AP1000
Existing Coal	All coal units available for shutdown based on emission target
New Coal	New coal allowed with CCS
Gas Additions	Expansion option allowed
EEDR	Ensure a minimum level of EEDR plus additional amounts as part of the least cost plan
Renewables (Utility Scale)	Expansion option allowed
Purchased Power Agreements (PPA)	Expansion option allowed with preference provided to non-emitting technologies
DG/DER	At minimum current renewable programs base case assumptions but allow expansion
Transmission	Upgrades (to include some 500 kV) for idle of most coal and new EHV or HVDC tie(s) to support growth in renewables

TVA Strategy C – Lean On the Market

Description:

- Most new capacity needs are met using market resources and/or third-party assets acquired through PPA or other bilateral arrangements
- TVA makes a minimal investment in owned assets (deployment of EEDR to meet resource needs will continue)

Attributes	Comments
Existing Nuclear	Retain existing units through the end of the study window; uprates are not allowed
Nuclear Additions	Complete WBN2 and no new nuclear expansion
Existing Coal	Based on current fleet strategy with special attention to additional clean air capital investment
New Coal	PPA is allowed
Gas Additions	No expansion option allowed
EEDR	Ensure a minimum level of EEDR plus additional amounts if cheaper than PPA
Renewables (Utility Scale)	No TVA builds of renewables, but renewable PPAs allowed
Purchased Power Agreements (PPA)	Allow 3rd Parties to construct generation and sell energy to TVA Negotiate extensions to Caledonia and DEC Agreements
DG/DER	Allow 3rd party development of DG/DER and TVA would purchase capacity/energy
Transmission	Increase EHV/HVDC transmission import and EHV internal transfer capability; also upgrades for new imbedded IPPs and additional voltage support as required

Description:

- Allows only gas-fired resource expansion after WBN2 unit comes online
- Allowed EEDR contribution based only on EPA requirements

Attributes	Comments
Existing Nuclear	Retain existing units through the end of the study window; uprates allowed
Nuclear Additions	Complete WBN2 and no new nuclear expansion
Existing Coal	Based on current fleet strategy
New Coal	No additions
Gas Additions	Expansion option allowed
EEDR	Minimum level only
Renewables (Utility Scale)	No expansion option allowed
Purchased Power Agreements (PPA)	Expansion option allowed if source is gas
DG/DER	At minimum current renewable programs base case assumptions plus any additional resources if powered by gas
Transmission	Upgrades necessary for coal idling and interconnection of new resources

Description:

- In order to establish TVA as a regional energy efficiency leader, a majority of capacity needs are met by setting an annual energy target for EEDR (e.g., minimum contribution of 1% of sales)
- Renewable energy and gas are secondary options with no coal or nuclear additions permitted

Attributes	Comments
Existing Nuclear	Retain existing units through the end of the study window; uprates allowed
Nuclear Additions	Complete WBN2 and no new nuclear expansion
Existing Coal	Higher compliance cost coal units are progressively idled to minimal levels.
New Coal	No additions
Gas Additions	Expansion option allowed
EEDR	Steady EE growth across customer base with minimum annual incremental of 1% of sales
Renewables (Utility Scale)	Steady growth of utility-scale renewable energy projects; total annual renewable energy target of 0.25%/yr of sales (~22% renewables by 2040).
Purchased Power Agreements (PPA)	Primarily focused on NG purchases as needed to balance intermittent resources
DG/DER	Steady growth of distributed renewables primarily occurring through customer programs; total annual renewable energy target of 0.25%/yr of sales (~22% renewables by 2040)
Transmission	Primary focus on grid expansion of EHV/HVDC.

Description:

- In order to establish TVA as a regional renewable leader, a majority of new capacity needs are met by setting immediate and long-term renewable energy targets (e.g., 20% by 2020 and 35% by 2040), including hydroelectric energy
- A utility-scale approach is targeted initially with growing transition to distributed generation as the dominant renewable resource type by 2024
- EEDR and gas are secondary options with no coal or nuclear additions permitted

Attributes	Comments
Existing Nuclear	Retain existing units through the end of the study window; uprates allowed
Nuclear Additions	Complete WBN2 and no new nuclear expansion
Existing Coal	Higher compliance cost coal units are progressively idled to minimal levels
New Coal	No additions
Gas Additions	Expansion allowed to manage increased load swings caused by intermittent renewable resources
EEDR	Steady EE growth across customer base
Renewables (Utility Scale)	Growth in renewables based on target of 20% by 2020 and 35% by 2040; equivalent to an annual energy target of 0.75%/yr of sales
Purchased Power Agreements (PPA)	Primarily focused on NG purchases as needed to balance intermittent resources
DG/DER	Utility-scale renewables are targeted initially with growing transition to distributed generation as the dominant renewable resource type by 2024
Transmission	Primary focus on distribution grid optimization and transmission and distribution balancing

Description:

- Reducing water use becomes a higher priority in resource planning
- Mitigate energy resource risk due to water dependence and promote integrated resource stewardship by restricting energy resource and cooling system technologies to options with lower water impacts with preference for air-cooled methods.
- Additionally, preferentially target energy efficiency efforts in local water treatment infrastructure

Attributes	Comments
Existing Nuclear	Retire existing units after 60-year operating life; no uprates allowed
Nuclear Additions	No BLN, Allow SMR (prefer air-cooled condenser)
Existing Coal	"Aggressive" retirement schedule based on a water use target
New Coal	Only if dry cooling is available
Gas Additions	Expansion option allowed only with dry cooling or "grey" water cooling
EEDR	Pursue all EEDR opportunities (preference for EE efforts in local water treatment energy use)
Renewables (Utility Scale)	Pursue PV, wind, additional hydro in TN Valley
Purchased Power Agreements (PPA)	Pursue out-of-Valley renewables and gas PPA options
DG/DER	Pursue end use generation
Transmission	Upgrades (to include some 500 kV) for idle of most coal and new EHV or HVDC tie(s) to support growth in renewables

Description:

- Pursue an orderly, but prompt, shutdown of the current nuclear fleet
- WBN2 allowed to go commercial as part of a bridging strategy to facilitate early shutdown of older nuclear units
- Development work is terminated at BLN

Attributes	Comments
Existing Nuclear	Schedule planned shutdown of existing nuclear capacity over a possibly 10 to 15 year interval. Decision is to decide the order and timing of the shutdown of each unit within the context of obtaining/installing replacement generation resources and maintaining grid stability
Nuclear Additions	No nuclear additions are a scenario assumption. WBN2 does not become commercial. (alternatively, WNB2 is completed and becomes commercial; it is the last nuclear unit to be shutdown - used as part of a bridge strategy)
Existing Coal	Improve material condition and generation flexibility of remaining units to bridge the nuclear gap while new gas units, and possibly new coal units, are developed and built.
New Coal	Accelerate development of Integrated Gasification Combined Cycle and/or Oxygen Fired Pulverized Coal Combustion Units, preferably at existing "brownfield" sites
Gas Additions	Expansion option allowed; may need to relax some model constraints to allow for more gas additions in the same year and/or more additions overall
EEDR	Pursue EEDR opportunities consistent with a least cost plan; focus on targeted implementation to leverage impacts for balancing transmission needs
Renewables (Utility Scale)	Expansion option allowed; renewables & storage technologies are coupled to enable significant expansion
Purchased Power Agreements (PPA)	Expansion option allowed
DG/DER	Expansion option allowed; renewables & storage technologies are coupled to enable significant expansion.
Transmission	Upgrades to accommodate nuclear retirements and coal and gas additions

TVA is refining the strategies with the objective of covering a wide range of values for the attributes

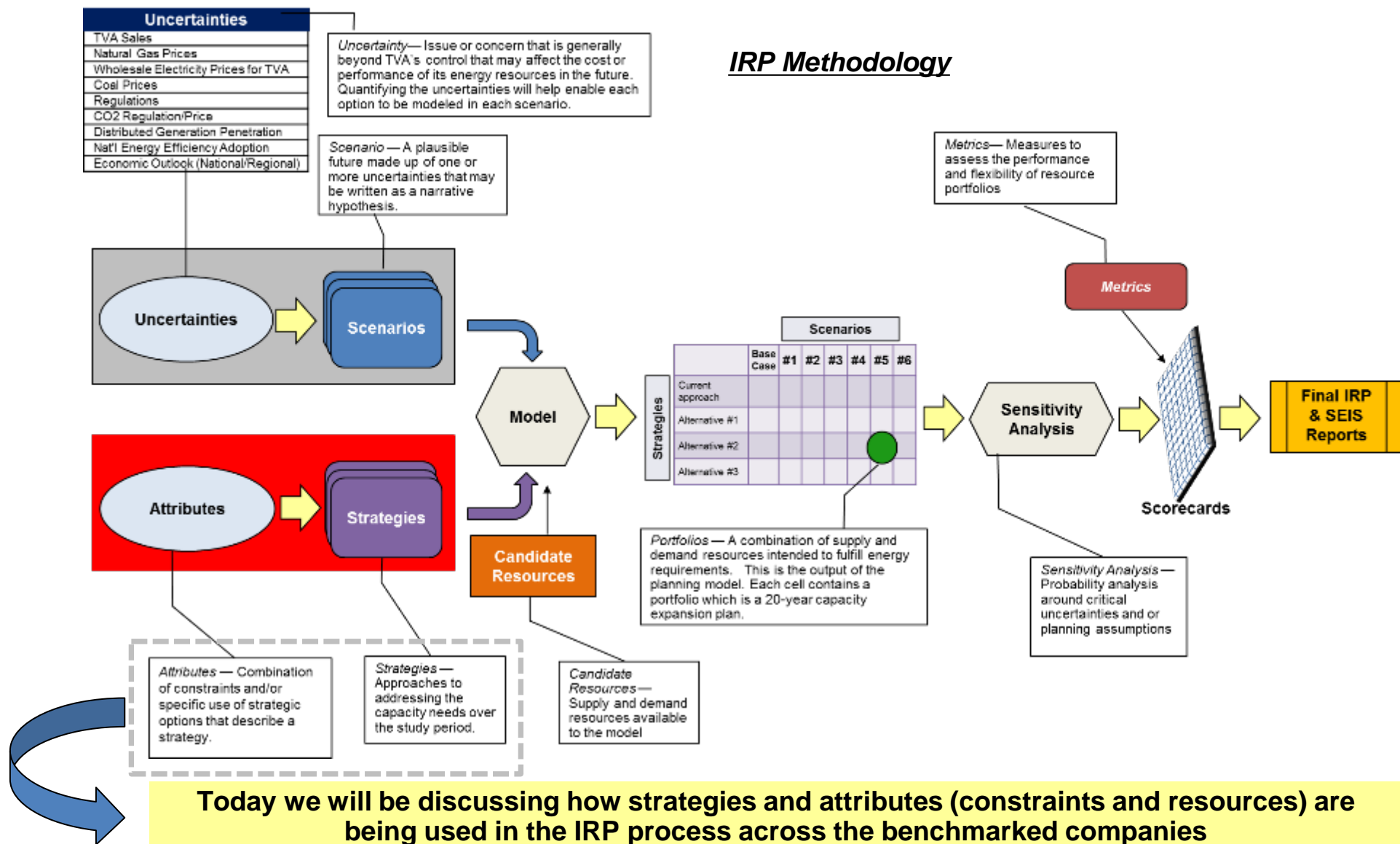
Map of Attribute Diversity

STRATEGY ATTRIBUTES	Promoted	Available	Limited	Excluded
Existing Nuclear	0	6	1	1
Nuclear Additions	0	2	5	1
Existing Coal	1	2	5	0
New Coal	1	2	2	3
Gas Additions	0	6	1	1
EEDR	2	5	1	0
Renewables (Utility Scale)	3	4	0	1
Purchased Power Agreements	1	2	5	0
Distributed Generation / Distributed Energy Resources	3	4	1	0

Note: Numbers reflect the number of strategies in which the attribute falls into one of these 4 classifications

Attributes and Strategies

TVA continues with the process of benchmarking the IRP filings of 8 comparable utilities



Companies Included in the Benchmarking Study

- ◆ The companies being benchmarked include:

Company	Filing Date	Planning Horizon
Duke Energy Carolinas (DEC)	Oct 2013	2014 - 2028
Florida Power & Light (FPL)	Apr 2013	2013 - 2022
Georgia Power Company (GPC)	Jan 2013	2013 - 2032
PacifiCorp (PCQ)	Apr 2013	2013 - 2032
Progress Energy Carolinas (PEC)	Nov 2012	2013- 2027
Dominion (DOM)	Aug 2013	2014 - 2038
Entergy (ETR)	Oct 2012	2012 - 2031
Arizona Public Service (APS)	March 2012	2013 - 2027

- ◆ These companies were selected based on the following characteristics:

- Similar generation mix and size (nuclear, coal, gas, hydro, etc.)
- Regional player (e.g., Georgia Power)
- Recently completed IRP (late 2012 or 2013)
- Inclusion in previous (2009-2010) TVA IRP benchmarking study

Strategies Around Gas, EEDR, and Renewables Are Most Prevalent

IRP Strategy	TVA 2015	DEC 2013	FPL 2013	GPC 2012	PCQ 2013	PEC 2012	DOM 2013	ETR 2012	APS 2012
"Traditional" Least Cost Planning	✓	✓	✓	✓	✓	✓	✓	✓	✓
Meet an Emission Target	✓		Strategy Development Information Unavailable						
Lean on the Market	✓								
Do Gas Only	✓	✓						✓	✓
Doing More EEDR	✓				✓	✓		✓	
Promoting Renewables	✓				✓		✓		✓
Energy-Water Nexus	✓								
No Nuclear	✓								
Focus on Nuclear		✓							
No Thermal Base load					✓				
Geothermal RPS					✓				
Fuel Diversity							✓		
Pursue Coal							✓		
Offshore Wind							✓		
Climate Action Plan							✓		
Coal Retirement									✓

- ◆ The number of strategies developed by benchmarked companies ranges from one to six
- ◆ On average, each company models between three and four strategies (does not include FPL)
- ◆ The most prevalent strategies being explored are:
 - Do Gas Only
 - More EEDR
 - Promoting Renewables

In Appendix B we have included a description of strategies and attributes used by benchmarked utilities

Other Strategies Considered by Benchmarked Companies

Strategy Title	Company	Description	Why not at TVA?
Focus on Nuclear	Duke Energy Carolinas	Designed around the addition of 2,234 MW Nuclear in 2022-2024	Only partially reflected in strategy B by letting nuclear resources compete with other low emissions options.
No Thermal Base load	PacifiCorp	No thermal base load resources allowed (gas-fired combined cycle units). Includes acceleration of DSM adoption	This strategy is not directly addressed; however, in strategy B and C we anticipate a minimal contribution of new base-load resources
Geothermal RPS	PacifiCorp	Meet RPS requirements with Geothermal. Any shortfall met with other renewables	Geothermal is not considered a viable resource for TVA
Fuel Diversity	Dominion	Address reliability, fuel diversity, price stability, and environmental compliance. Places greater reliance on generation resources with little or no GHG emissions	Very similar to strategy B at TVA
Pursue Coal	Dominion	Allows development of coal with carbon sequestration	Not directly addressed, but the potential for new coal is most likely in strategy H (coal will compete with other potential base or intermediate options in the absence of nuclear)
Offshore Wind	Dominion	Includes significant wind resources: 1,600 MW offshore wind and 12 MW onshore wind demo project	Offshore Wind is not considered a resource for TVA (but it might be proposed as part of a PPA offer)
Climate Action Plan	Dominion	Strategy is designed to reduce emissions in line with the President's proposed Climate Action Plan	Very similar to strategy B
Coal Retirement	APS	Retire all coal by 2024 and replace with natural gas and renewables	This strategy is partially tested by strategy F (and to a lesser extent in E and G)

Technologies Considered for New Capacity Needs

Technology Evaluated for Planning Purposes	TVA 2015	DEC 2013	FPL 2013	GPC 2012	PCQ 2013	PEC 2012	DOM 2013	ETR 2012	APS 2012
Coal Fired									
Circulating Fluidized Bed ("CFB")				X			X	✓	
Pulverized Coal		✓		✓	✓	✓	✓	✓	X
IGCC				✓	✓	X	✓		X
Gas Fired									
Gas Fired Combustion Turbine		✓		✓	✓	✓	✓	✓	✓
Gas-Fired Combined Cycle		✓	✓	✓	✓	✓	✓	✓	✓
Internal Combustion Reciprocating				X	✓				
Small Scale Aeroderivatives								✓	
Nuclear									
Nuclear		✓	✓	✓	✓	✓	✓	✓	X
Nuclear Fusion							X		
Small Modular Reactors ("SMR")		X					X		
Renewables									
Biomass		✓		✓	✓	✓	✓	✓	✓
Concentrating Solar				✓	✓		X		X
Fuel Cell		X		✓		X	X		
Geothermal		X		X	✓		X		✓
Hydro						X	X		
Landfill Gas				✓		✓			
Offshore Wind		X		✓	✓	X	✓		
Onshore Wind		✓		✓	✓	✓	✓	✓	✓
Poultry and swine waste digesters		X							
Solar PV		✓		✓	✓	✓	✓	✓	✓
Tidal and Wave Power				✓			X		
Storage									
Battery		X		✓			X		✓
Compressed Air		X		✓			X		✓
Flywheel				X	✓		X		
Pumped Storage				✓					

Detailed Screening Information Not Available

Observations:

- ◆ Only APS excluded nuclear as a potential generation alternative
- ◆ Evaluation of renewables was mixed, but most companies included biomass, solar PV, and onshore wind
- ◆ Storage resources were not heavily considered
- ◆ Technologies included most often by category are:
 - Coal: pulverized coal
 - Gas: combined cycle and combustion turbine
 - Nuclear: traditional nuclear
 - Renewables; biomass, Wind, Solar PV
 - Storage: batteries, compressed air

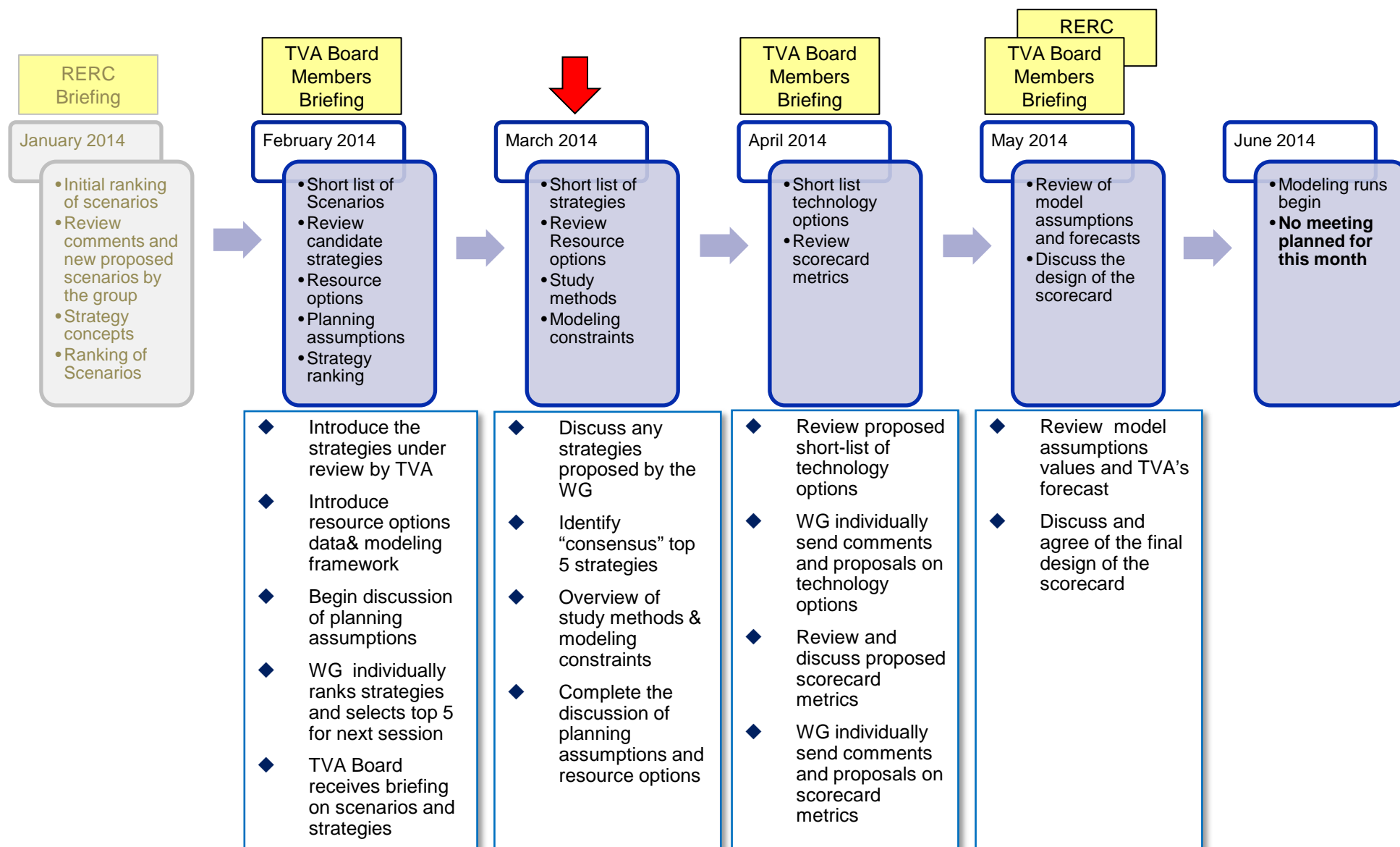
Appendix B includes a more detailed descriptions of some of the resources and constraints used in the different strategies tested by the benchmarked companies

Ranking of Proposed Strategies by the IRPWG

- ◆ We ask the working group to individually select their top five strategies (1st being their top selection) to be modelled during the rest of the IRP process
- ◆ We will provide a ranking template (similar to the one used for scenario ranking)
- ◆ Ranking criteria could include:
 - Diversity and Flexibility of the mix of resources
 - Interesting strategy that should be analyzed by TVA
 - Strategy that addresses a key policy direction for TVA
- ◆ The members of the working group can propose new strategies as part of their selection if they believe the current list of candidate strategies does not adequately address a key resource mix issue
- ◆ The working group needs to submit their rankings via email no later than Monday, March 3rd so we can prepare composite ranking metrics to share at the March meeting

Meeting Objectives for IRPWG Through June 2014

- ◆ Next meeting will be on March 27th and 28th in Chattanooga, TN



2011 IRP Strategies

Attributes	Strategy A	Strategy B	Strategy C	Strategy D	Strategy E
	Limited Change in Current Resource Portfolio	Baseline Plan Resource Portfolio	Diversity Focused Resource Portfolio	Nuclear Focused Resource Portfolio	EEDR and Renewable Focused Resource Portfolio
EEDR	1,940 MW & 4,725 annual GWh reductions by 2020 (Iteration 12)	2,100 MW & 5,900 annual GWh reductions by 2020 (FY11 LRFP / 10.75)	3,600 MW & 11,400 annual GWh reductions by 2020 (BLN case / 10.5)	4,000 MW & 8,900 annual GWh reductions by 2020 (based on EPRI)	5,900 MW & 14,400 annual GWh reductions by 2020 (aggressive 11.1)
Renewable Additions	1,300 MW & 4,600 GWh competitive renewable resources or PPAs by 2020	Same as Planning Strategy A	2,500 MW & 8,600 GWh competitive renewable resources or PPAs by 2020	Same as Planning Strategy C	3,500 MW & 12,000 GWh competitive renewable resources or PPAs by 2020
Fossil Asset Layup	No fossil fleet reductions	2,000 MW total fleet reductions by 2017	3,000 MW total fleet reductions by 2017	7,000 MW total fleet reductions by 2017	5,000 MW total fleet reductions by 2017
Energy Storage	No new additions	Same as Planning Strategy A	Add on pumped-storage unit	Same as Planning Strategy C	Same as Planning Strategy A
Nuclear	No new additions after WBN2	First Unit online no earlier than 2018 Units at least 4 years apart	Same as Planning Strategy B	First unit online no earlier than 2018 Units at least 2 years apart	First unit online no earlier than 2022 Units at least 2 years apart Additions limited to 3 units
Coal	No new additions	New coal units are outfitted with CCS First unit online no earlier than 2025	Same as Planning Strategy B	Same as Planning Strategy B	No new additions
Gas-Fired Supply (Self-Build)	No new additions	Meet remaining supply needs with gas-fired units	Same as Planning Strategy B	Same as Planning Strategy B	Same as Planning Strategy B
Market Purchases	No limit on market purchases beyond current contracts and extensions	Purchases beyond current contracts and contract extensions limited to 900 MW	Same as Planning Strategy B	Same as Planning Strategy B	Same as Planning Strategy B
Transmission	Potentially higher level of transmission investment to support market purchases Transmission expansion (if needed) may have impact on resource timing and availability	Complete upgrades to support new supply resources	Increase transmission investment to support new supply resources and ensure system reliability Pursue inter-regional projects to transmit renewable energy	Same as Planning Strategy C	Potentially higher level of transmission investment to support renewable purchases Transmission expansion (if needed) may have impact on resource timing and availability



Defined model inputs



Optimized model inputs

Strategies Developed By Other Utilities

DEC - 2013

Duke Energy devised three possible strategies during the 2012 IRP development process and settled on the Nuclear Full Ownership strategy. The 2013 IRP update continues to employ this same strategy:

- ◆ **No Nuclear**
 - Allows only CT and CC additions
- ◆ **Nuclear Full Ownership**
 - Designed around the addition of 2,234 MW of Nuclear in 2022-2024
- ◆ **Regional Nuclear**
 - Same as Nuclear Full Ownership strategy, but allows for regional partnerships rather than full ownership

FPL - 2013

FPL does not disclose specific resource or strategy options evaluated in the IRP process. The IRP does explain the process as follows:

“...resource plans are created by combining individual resource options so that the timing and magnitude of FPL’s projected new resource needs are met. The creation of these competing resource plans is typically carried out using spreadsheet and/or dynamic programming techniques”

GPC - 2012

GPC does not develop separate strategies for evaluation. Instead, the generation portfolio mix is determined through a dynamic modeling process within Strategist

- ◆ GPC develops the “benchmark plan” based on least-cost analysis that minimizes net present value of revenue requirement (PVRR) for the base case level of customer load
- ◆ The “benchmark plan” is then the basis for DSM assessment and stochastic analysis

PacifiCorp - 2013

PacifiCorp built 19 input scenarios, around 4 themes. Three of the “cases” involved constraints on supply-side resources and thus are considered strategies for purposes of comparison

- ◆ **No Thermal Base Load**
 - No combined cycle resources allowed
 - Acceleration of EE/DSM
- ◆ **Geothermal RPS Strategy**
 - Use geothermal to meet RPS requirements
 - Any shortfall is met with renewable energy
- ◆ **Clean Energy Bookend:**
 - Targets clean energy resources
 - Acceleration of EE/DSM
 - ITC/PTC extended through 2019

Strategies Developed By Other Utilities (Cont'd)

PEC - 2013

PEC developed five plans for inclusion in scenario analysis. Four of those plans were the output of the optimization process, and one plan was based on strategic decisions by PEC. However, their single strategy, the "Aspirational Plan," was not included in the scenario analysis:

◆ Aspirational Plan

- Includes significant emphasis on Energy Efficiency
- Hi EE levels reduce the overall energy requirement and thus limit the need for combined cycle units

DOM - 2013

Dominion developed five alternative plans or strategies for evaluation through scenario and sensitivity analysis (in addition to the "least cost" strategy):

◆ Fuel Diversity

- Address reliability, fuel diversity, price stability, and environmental compliance

◆ Renewables

- Test feasibility of meeting RPS requirements

◆ Coal

- Allow development of coal with carbon capture and sequestration

◆ Climate Action Plan

- Explore possible outcome of President's CAP
- Requires all coal units with less than 10,000 Btu/kWh heat rate
- Allows no more than 67% of generation to come from natural gas

◆ Offshore Wind

- Includes development of significant offshore wind resources (1,600 MW)

ETR - 2013

Entergy tested four strategies in scenario analysis:

◆ CCGT Dominant Portfolio

- Emphasis on combined cycle resources

◆ Combustion Turbine Dominant

- Emphasis on combustion turbine resources

◆ Balanced Portfolio

- Deploy a balanced mix of combustion turbine and combined cycle resources

◆ High DSM Portfolio

- Emphasize accelerated adoption of DSM

APS - 2013

Arizona Public Service developed four potential strategies including the base plan:

◆ Base Plan

- Deliver a portfolio that does not rely on any one specific fuel source
- Assumes rotation of coal units to meet environmental regulations
- No addition of base load allowed
- Meet growth with DR and natural gas
- Compliance levels of EE/RE

◆ Four Corners Contingency

- Full retirement of Four Corners Coal plant
- Compliance levels of EE/RE

◆ Enhanced Renewables

- 30% of need met with renewables (after DSM/EE) = 2x renewables in Base Plan
- Compliance levels of EE

◆ Coal Retirement

- Retire all coal generation by 2024 (1,700 MW)
- Replace with 25% renewables and 75% natural gas
- Compliance levels of EE