Determining the Value of TVA Energy Efficiency and Demand Response Programs

Presented at the 2013 ACEEE National Conference on Energy Efficiency as a Resource

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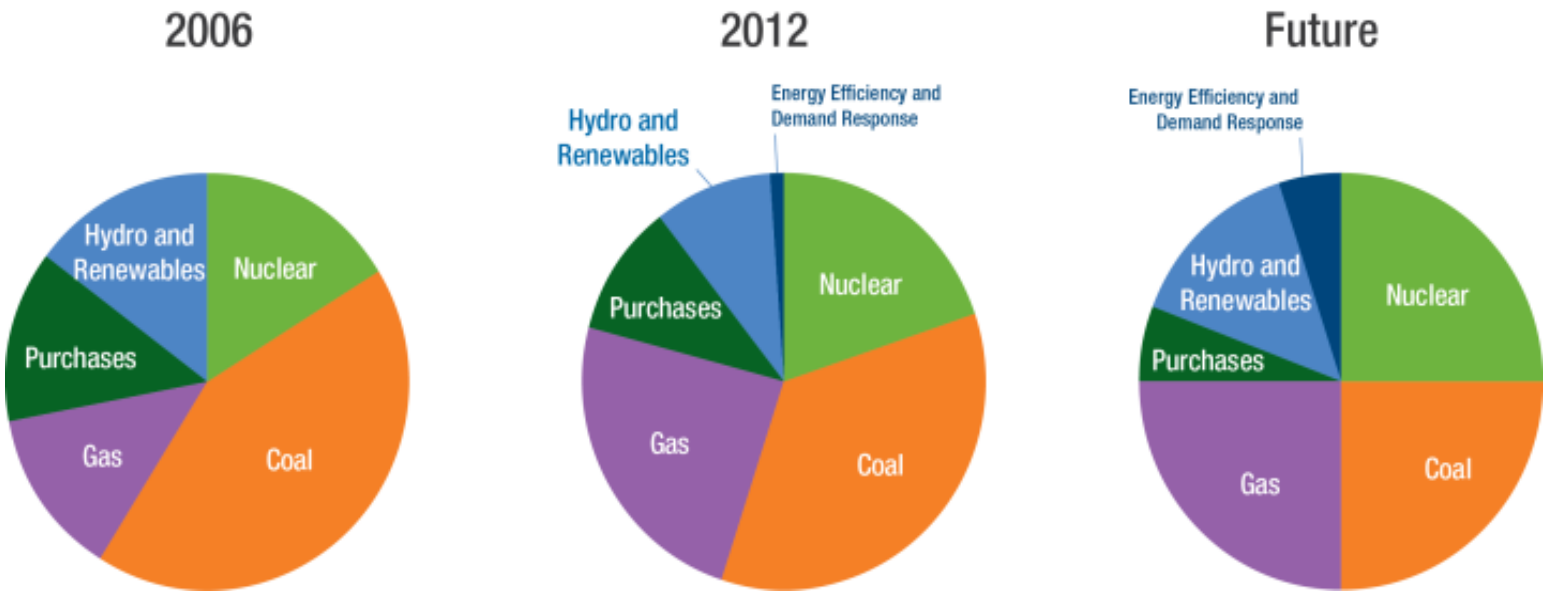
The Tennessee Valley Authority At a Glance

Seven State Service Area

Largest U.S. Public Power Provider

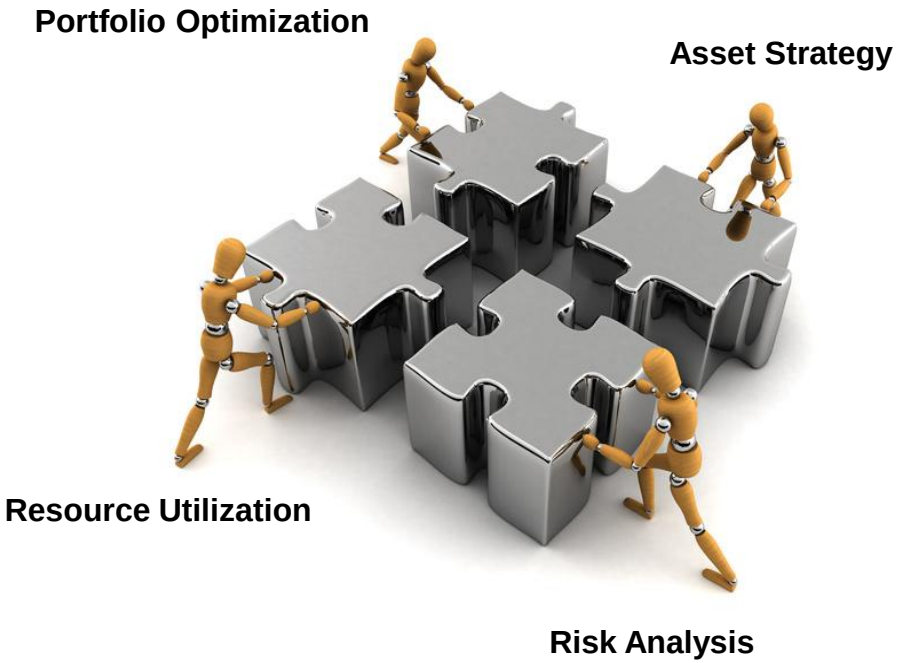
- Wholly owned U.S. government corporation created by Congress in May 1933
- Self-supported (no taxpayer funding)
- Unique customer base
  - 155 distributor customers
  - 57 large directly-served customers
- 9 million service area population
- 35 GW generating capacity
- $47 billion total assets; revenues > $10 billion

Diversified Generation Portfolio



About Resource Planners

Planners Solve Puzzles ….

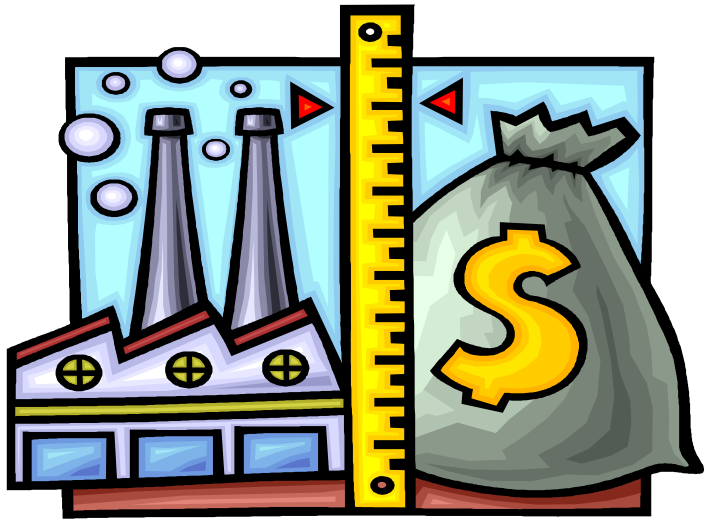


And we tend to ask a lot of questions, like …

How much energy will our customers use in the future?
Will we be able to meet the projected energy use?
Are additional resources needed?
What alternatives do we have to meet our resource needs?
Are there strategic considerations that will limit the alternatives we can consider?
How do we properly evaluate all of these resource alternatives?
How do we find the best solution?
Which plan (portfolio) do we select?

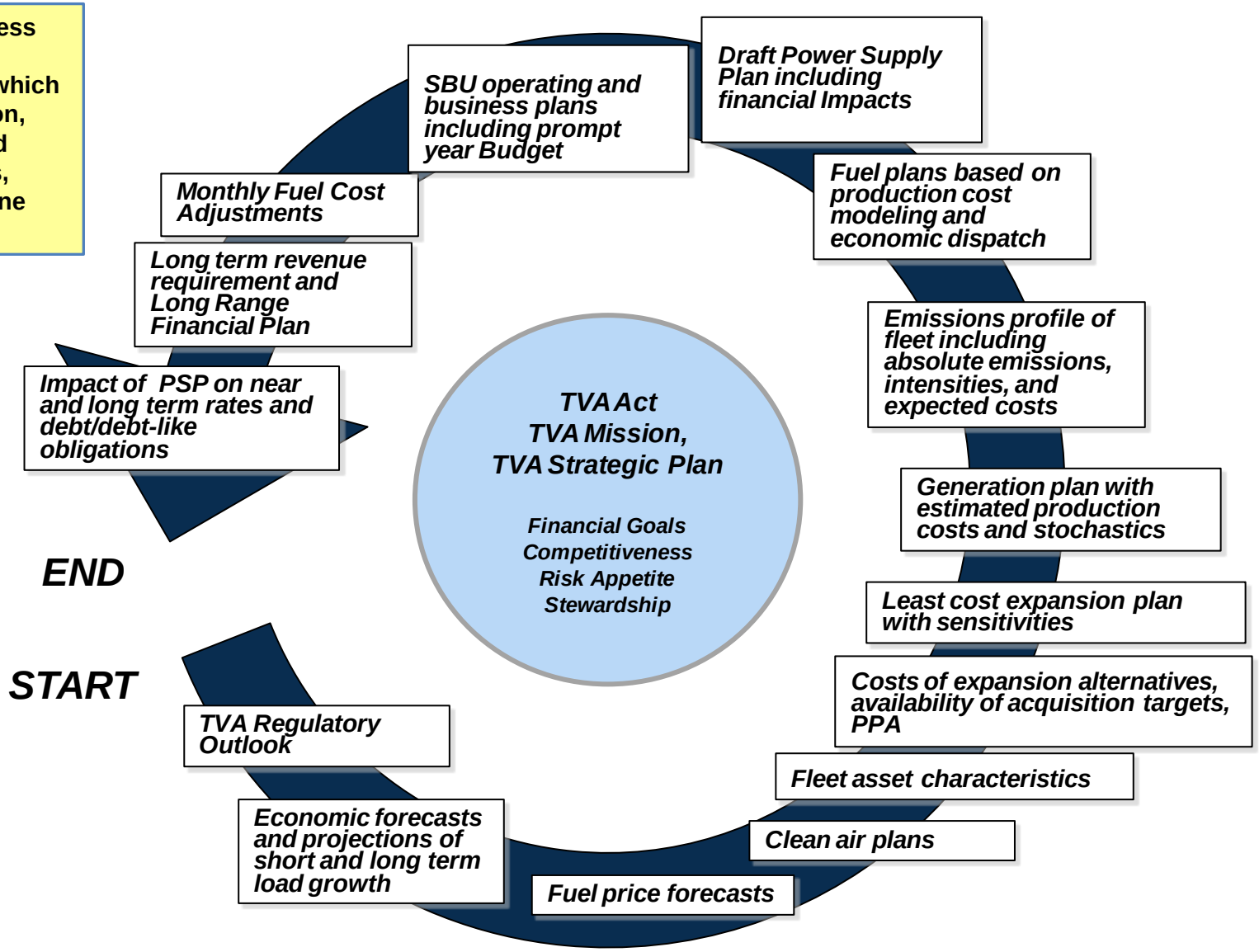
What We Do As Resource Planners

Resource planning is the application of economic and engineering analyses to the solution of the resource adequacy problem; namely, making investment decisions on behalf of customers such that the total all-in cost (i.e., fixed and variable costs) to the customer is minimized, while maintaining an appropriate level of resource adequacy



How We Do It

Planning process starts with assumptions which drive expansion, generation and financial plans, which determine rates



The Key Objective: Minimize Present Value Cost of Service to Customers

Using the reliability limit as a constraint, we optimize by minimizing the customer's delivered cost of power

The Planning Objective Function:

Minimize Exp(PV(Revenue Requirements))

or Min E(PV (RR))

Components:

- **Optimization**
- **Uncertainty**
- **Time-Value of Money**

- **Revenue Requirements**
  - **Operating Expenses**
  - **Return *of and on* capital**
- **Constraints**
  - **Planning reserve margin**
  - **Unit constructability**

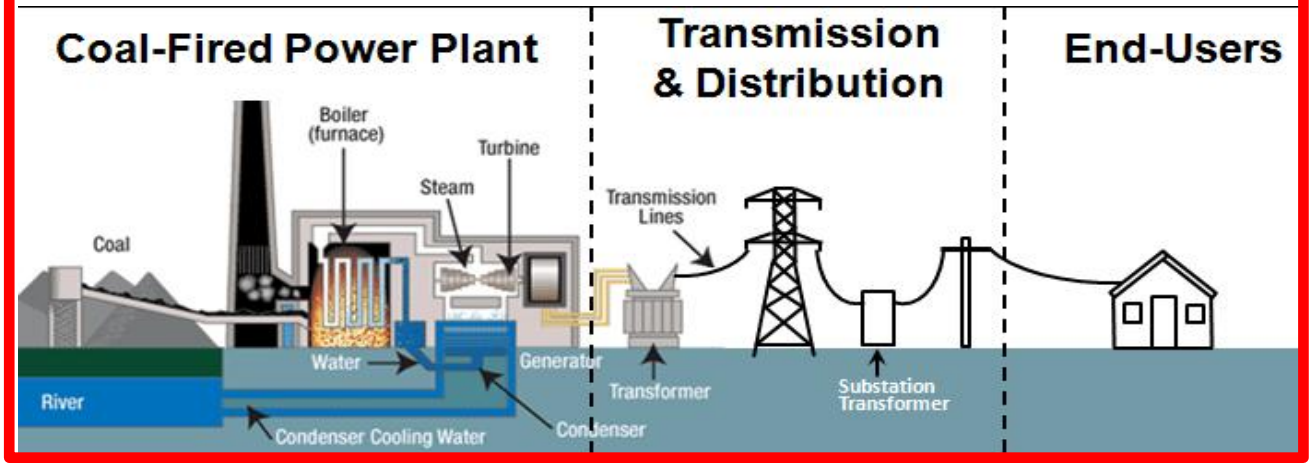
EE/DR Programs Have Two Basic Impacts That are Relevant to Planners

1. Avoided Energy Calculation:

- Energy not consumed, means fuel not burned, resulting in savings in variable costs. Further, since program impacts are felt at the meter, they also avoid transmission and distribution losses, which average 7% by the time energy reaches an end-user

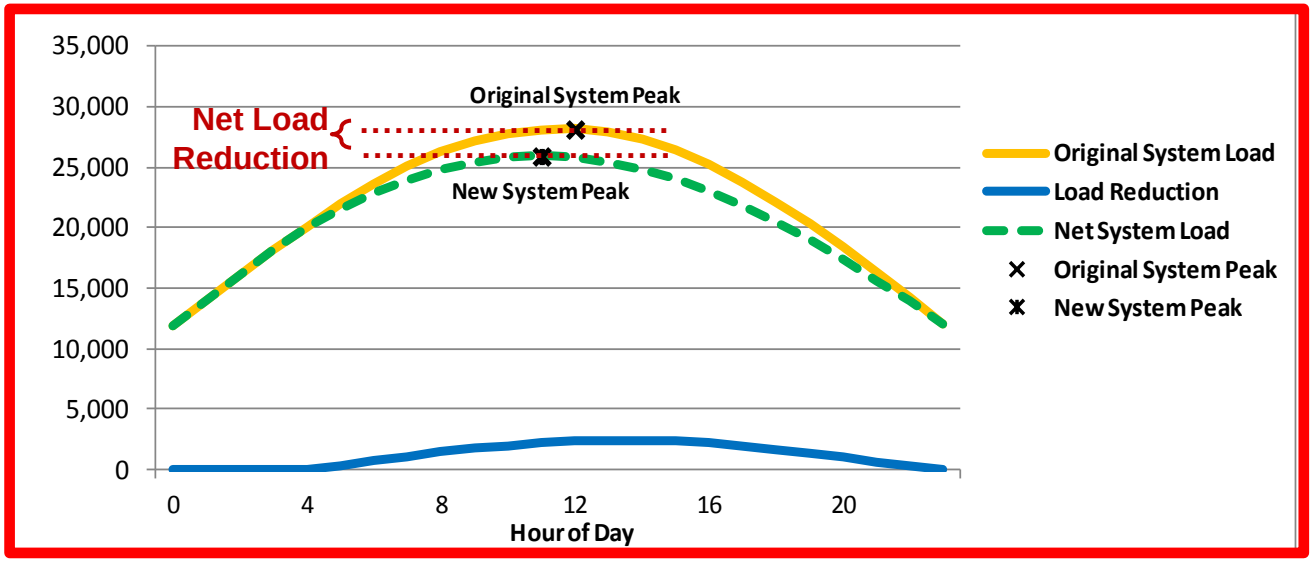
Concept: MW @ Generator → T&D → MW @ end-use-meter

(EE/DR) impacts are reductions @ the end-use-meter and are scaled up by 6.5%, representing T&D losses, to get MW comparable to generating station



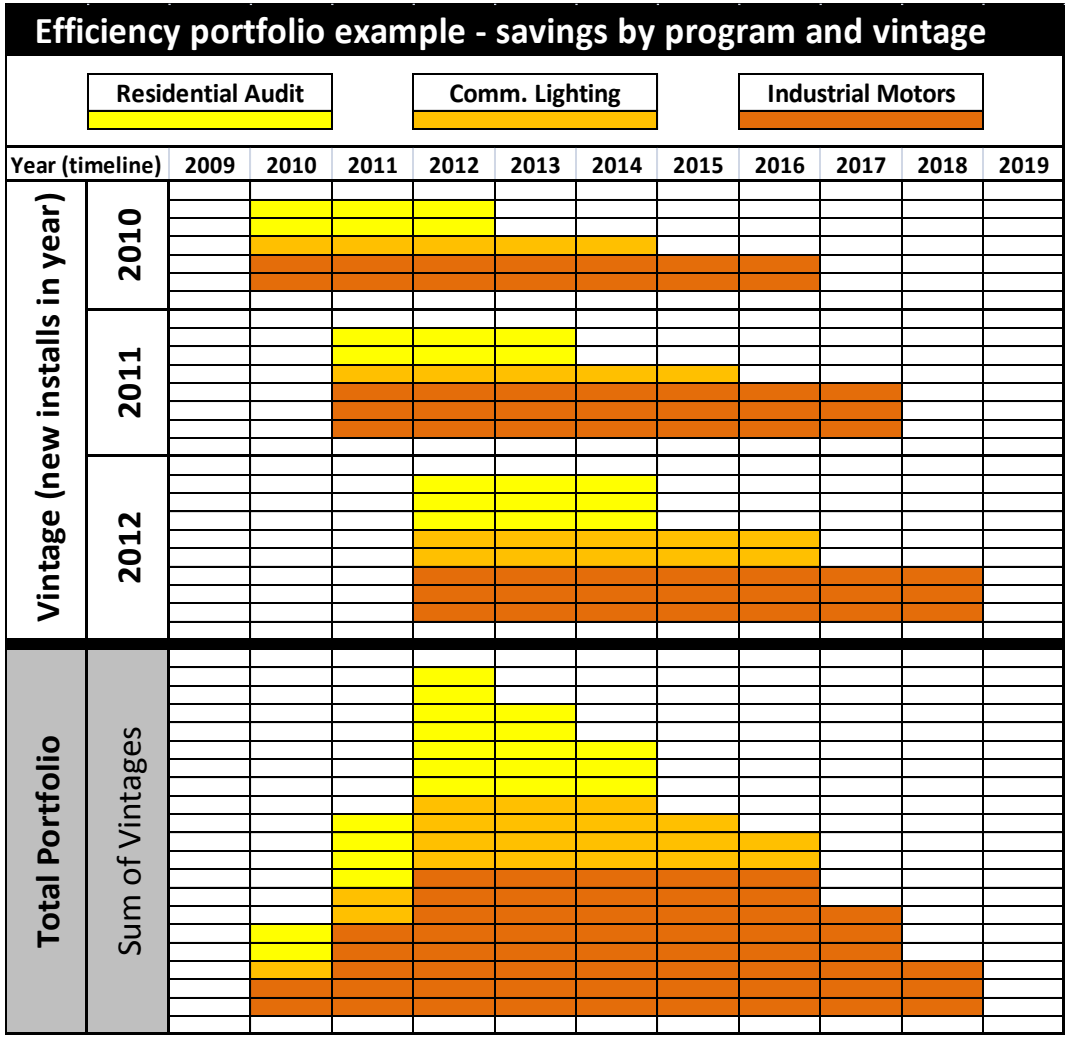
2. Avoided Capacity Calculation:

- **Capacity Avoided by Reduced Energy Demand,** since reduced demand translates into reduced need for costly base and peaking supply
- **Avoided Reserves,** since peak demands are lower, absolute value of target reserves also lower, and could impact % level for resource adequacy as well



EE/DR Programs Can be Viewed as a Portfolio of Many Small, Flexible Power Purchase Agreements

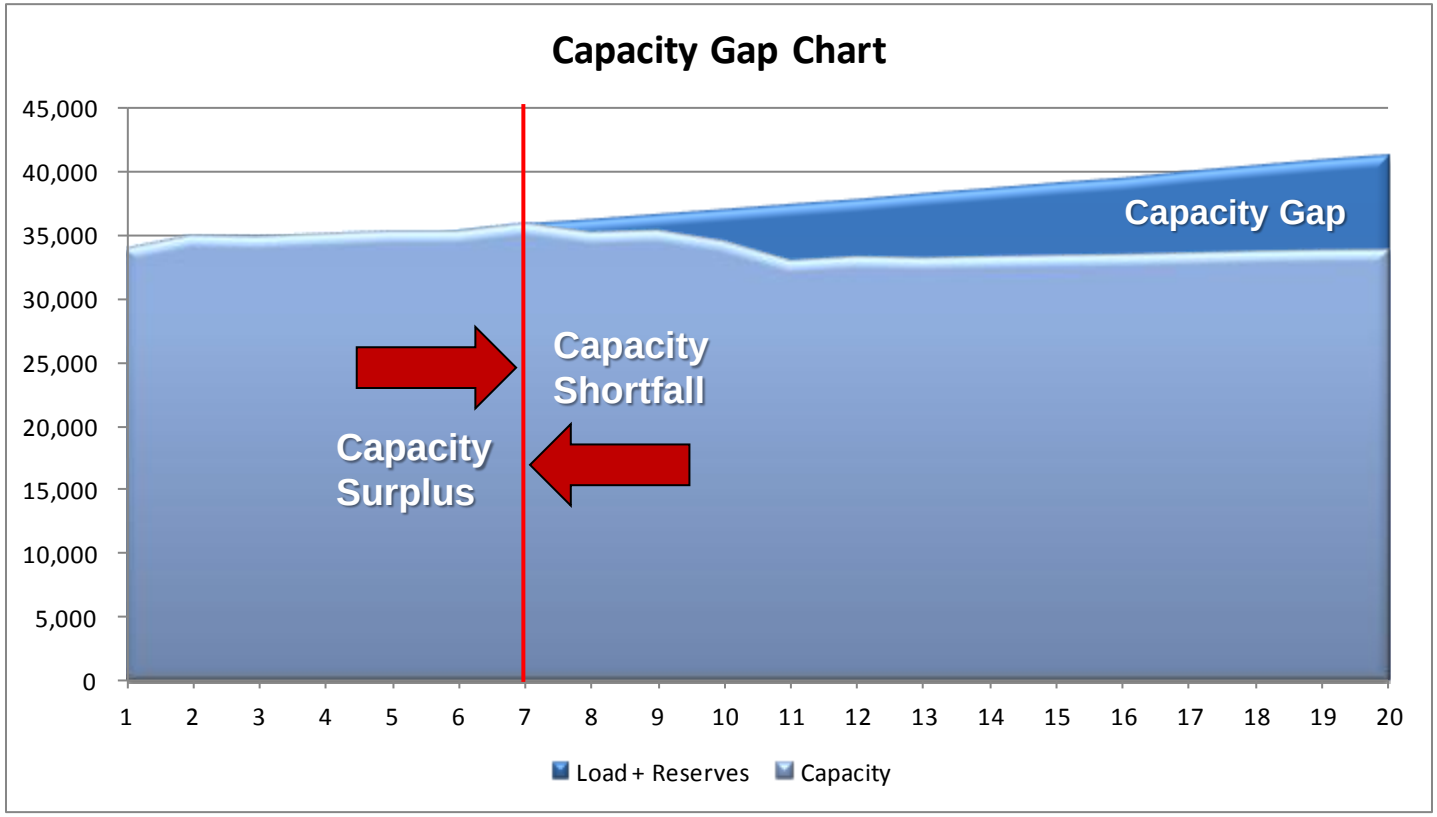
- Programs can be bundled together
- Each program will have a specific impact on capacity, energy, and time of day, and have an *expected* life
- Programs typically contain many similar units and ***offer the flexibility to scale up/down, in some cases***, quickly, acting as effective risk management tools to deal with load forecast error in the short term
- Total Portfolio impacts in any given year are a sum of unit-impacts from many programs from many **vintages**:
  - **Deployed effectively, turnover contributes to increased flexibility** and thus potential cost savings and effective risk management



Terms			Incremental			Annual			Cumulative			
Year (timeline)		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Vintage	2010		5	5	5	3	3	2	2			
	2011			6	6	6	4	4	3	3		
	2012				8	8	8	5	5	3	3	
Total			5	11	19	17	15	11	10	6	3	

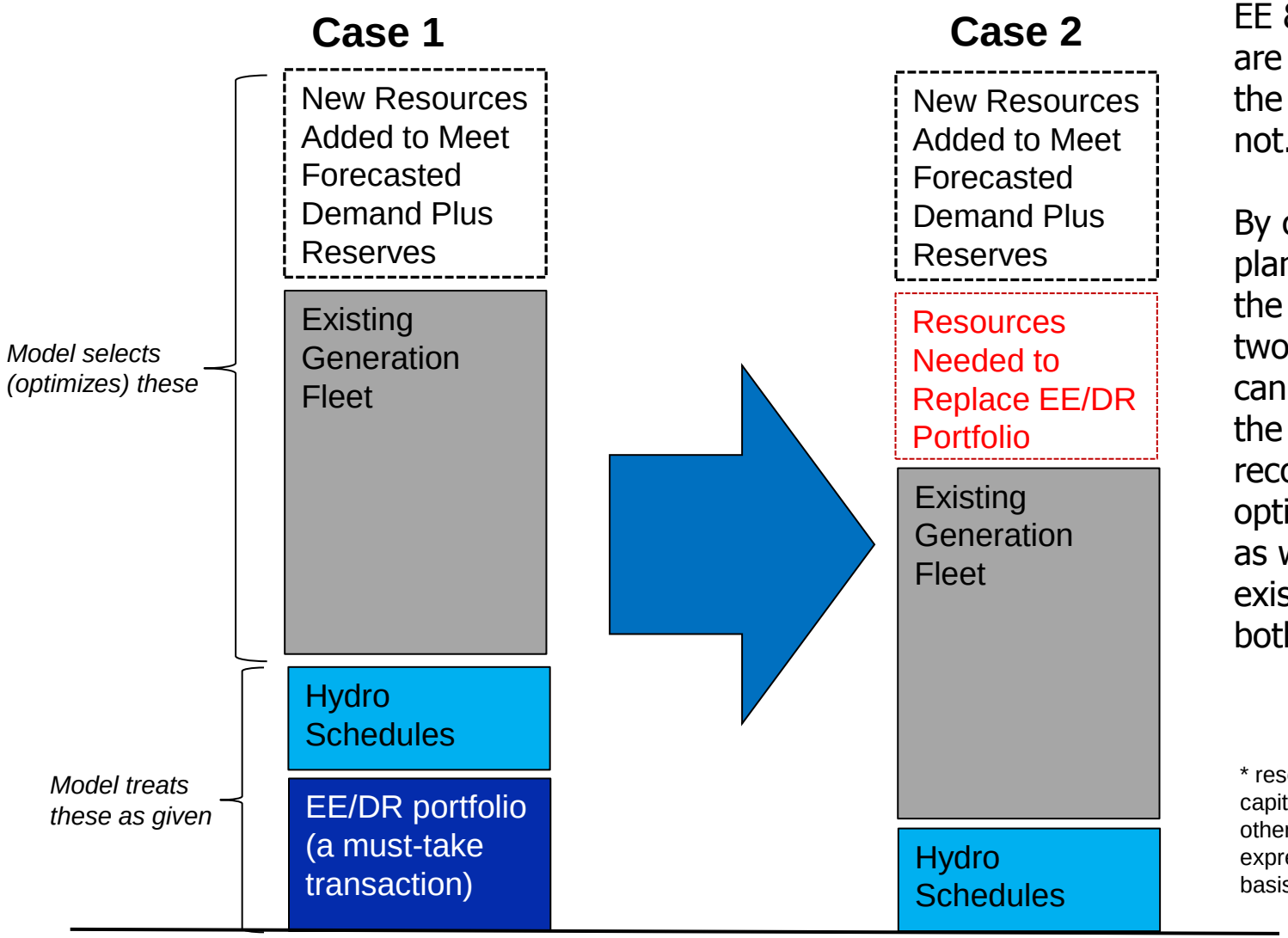
Resource Planning Addresses Future Capacity Needs

Resource planning is about optimizing the mix of future capacity. The planning exercise begins by identifying the point at which new capacity is required to maintain reliability. This capacity need (or gap) is the difference between firm requirements and system capability.



Projections of capacity needed (demand + reserves minus existing capacity) are filled by the most cost-effective resource such that total cost to customers is minimized over the 20-year planning horizon

A Planner's Approach to the Value of EE & DR



To determine the value of the EE & DR portfolio, two cases are modeled: one that includes the portfolio and one that does not.

By comparing the resource plans and the components of the plan costs* between these two cases, a value for EE&DR can be determined that reflects the value of this portfolio recognizing the other resource options that could be selected as well as the economics of the existing generating assets in both scenarios.

* resource plan costs include capital, other fixed costs, fuel and other variable costs, usually expressed on a present value basis

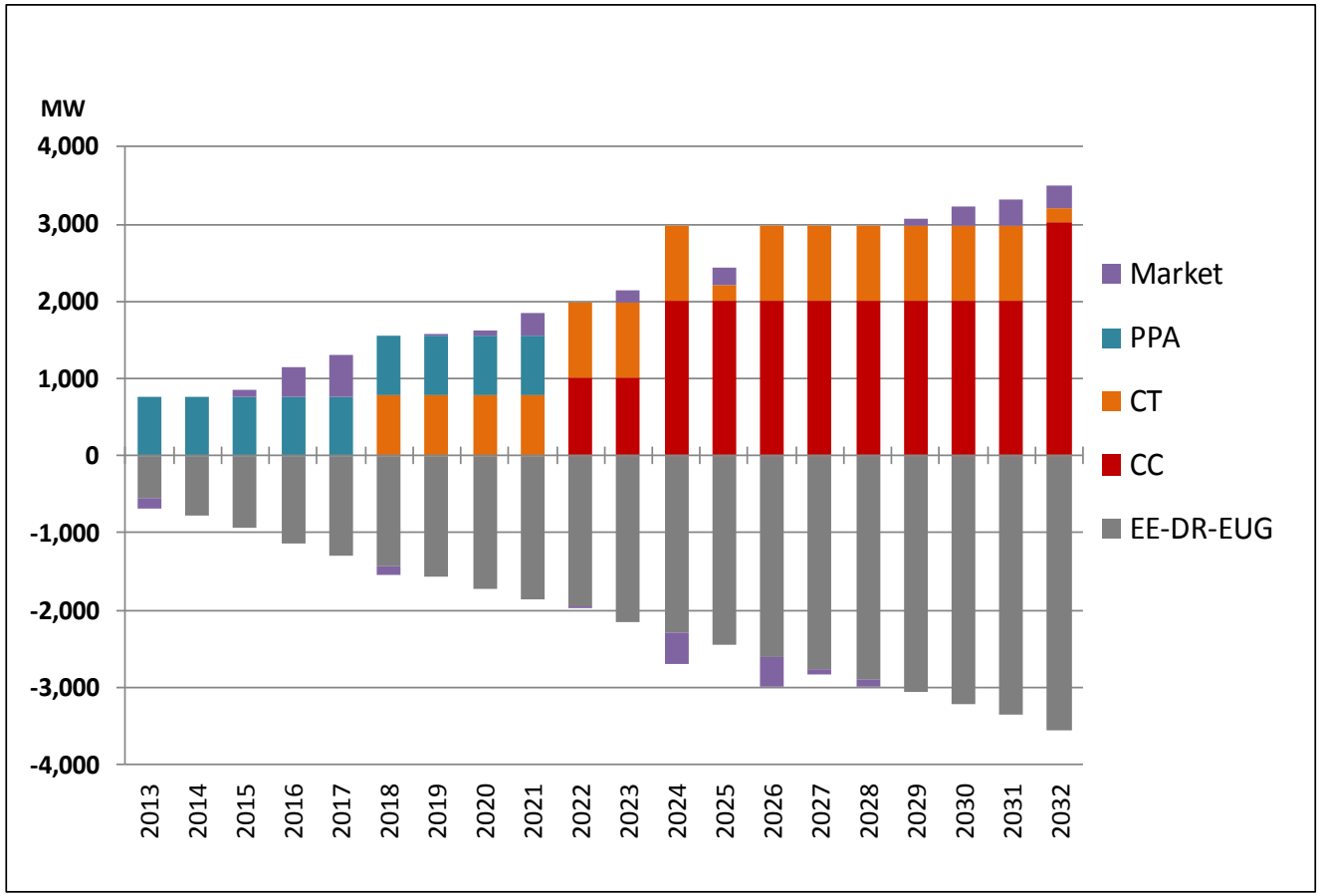
Capacity planning models close the gap between resources on hand and what is needed to serve forecasted requirements. Some resources are fixed (priority) resources while others can be optimized to achieve the lowest overall cost subject to constraints over the planning horizon.

Details of Replacement Capacity for EE/DR Portfolio

This capacity difference chart shows the mix of resources chosen to replace EE/DR contributions

In this particular scenario, initially the replacement capacity is contract/market purchases, until self-build gas units come into the plan beginning in 2018

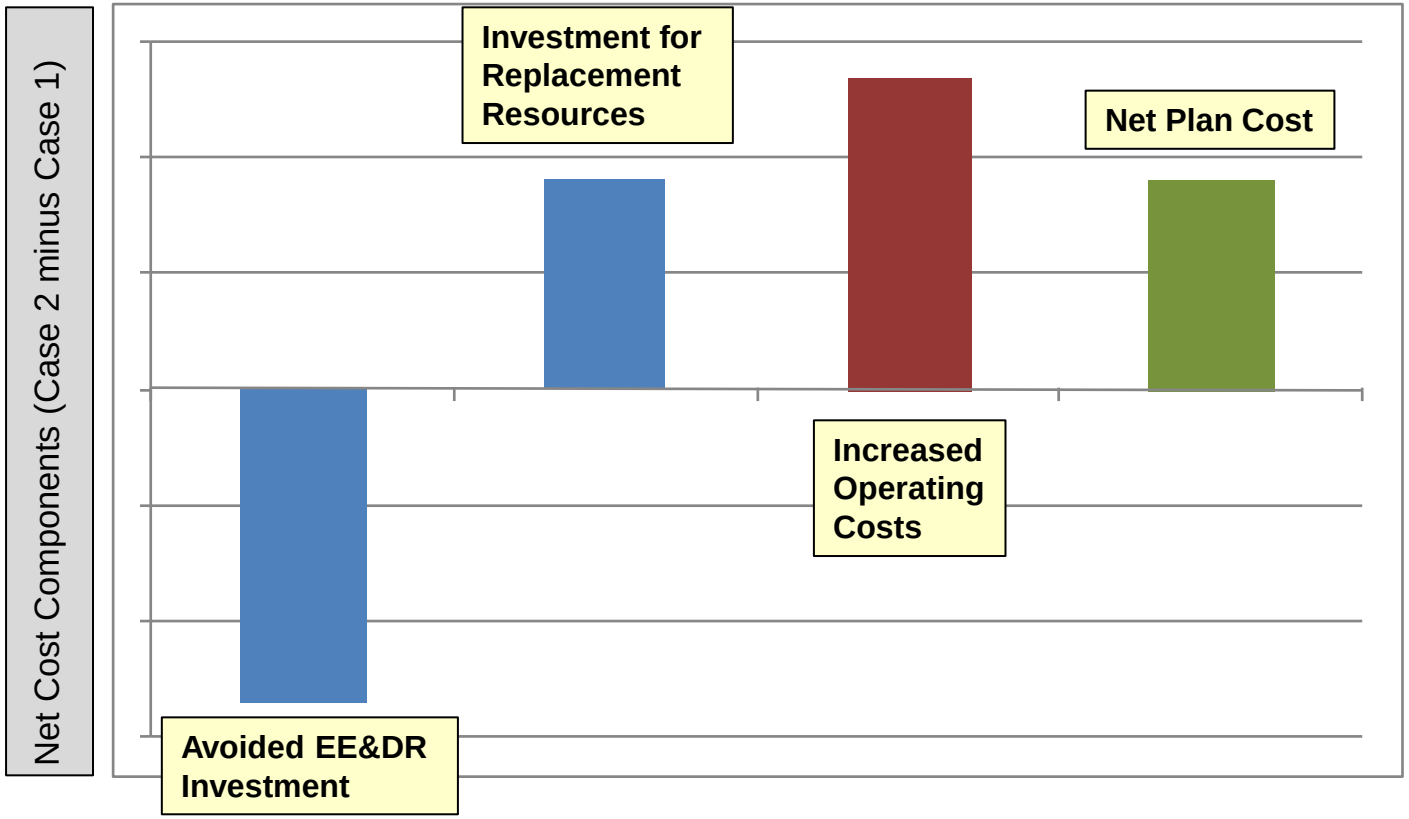
This result indicates that the EE&DR portfolio evaluated in this scenario has characteristics that are similar to both peaking and intermediate (NGCC) resources



Replacement capacity selection is based on capacity/energy needs, resource availability, operating flexibility, and total installed cost for each option

EE&DR Economics: Doing the Math

To determine the value of EE&DR in the resource portfolio, we net the EE&DR program costs against the investment in replacement resources including the increased operating costs incurred due to loss of the EE&DR contribution. This net plan cost represents the cost avoided by the plan that includes EE&DR and therefore is also the implied value from a resource planning perspective.



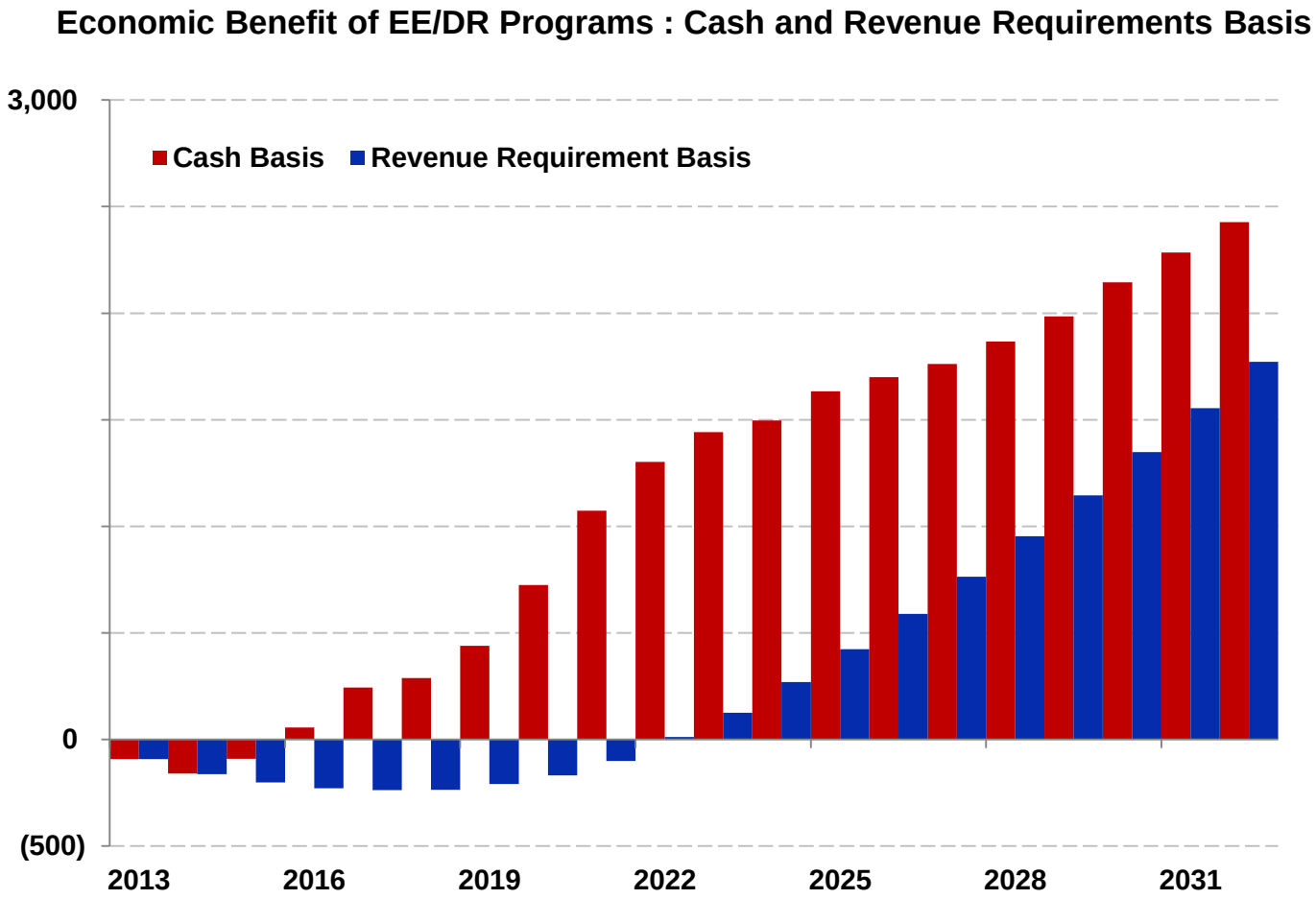
(the resource investment net of EE&DR costs) + (operating costs) = cost of a plan without EE&DR

- or the implied value of the EE&DR portfolio on a system basis

Cumulative EE/DR Portfolio Benefits Exceed $1.8BB (PV)

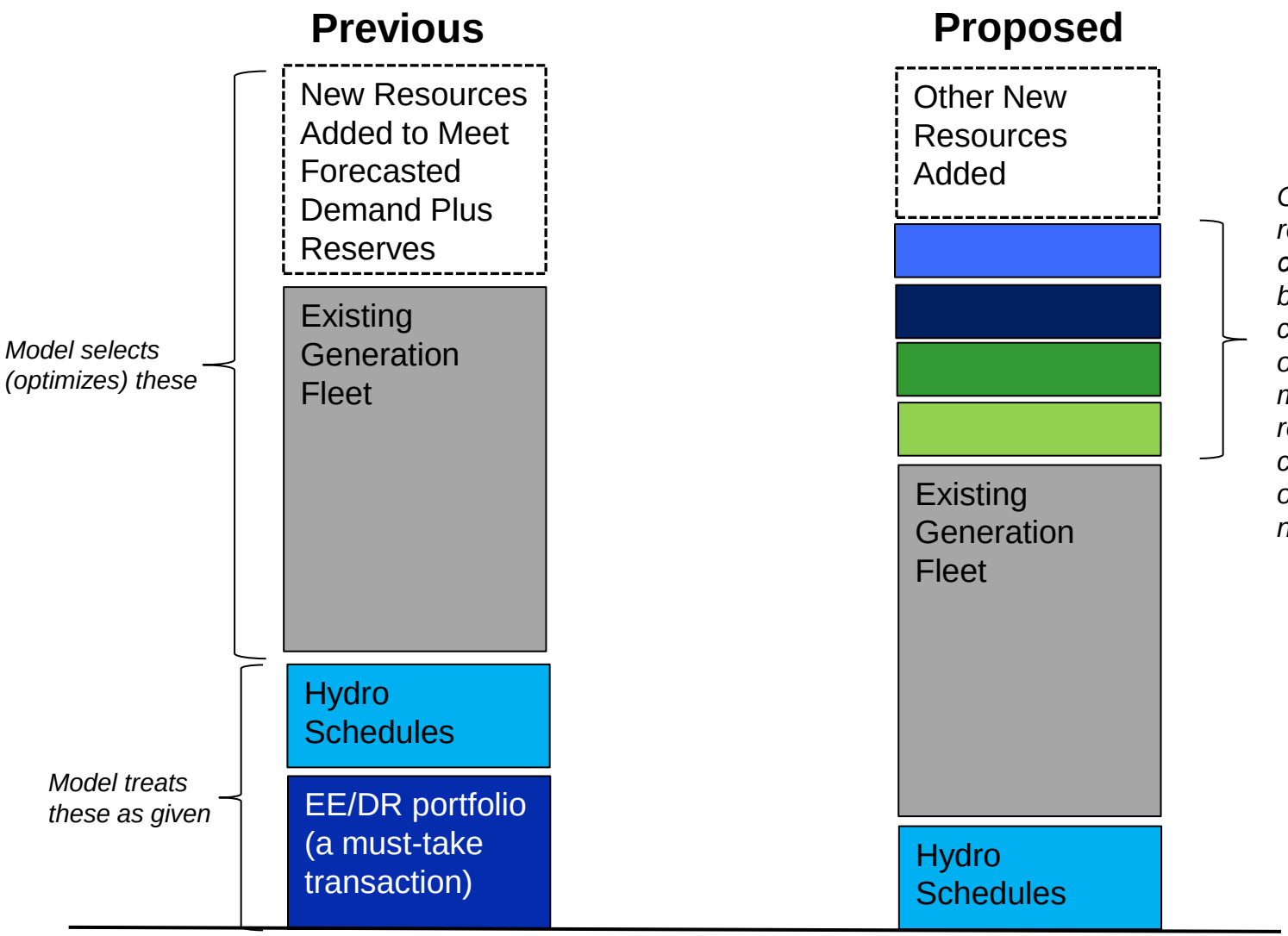
- In addition to the revenue requirements analysis, examination of the avoided cash costs indicates that the *EE/DR portfolio adds significant value to TVA's resource portfolio over the planning period*

- The combined EE/DR portfolio breaks even on a cash basis by 2016 (as significant cash investment begins on replacement) and on a revenue requirements basis by 2022



Valuing EE&DR in the 2015 IRP* Study

*** Integrated Resource Planning**



Using the previous method, the least cost capacity plan was developed using an EE&DR portfolio that had been designed outside the model using traditional cost-effectiveness tests. In this new method, we will be dynamically optimizing the total amount of EE&DR in the least cost plan using a "small block" technique

Concluding Remarks

- Results of System Planning analysis underscores ***valuable contribution of TVA's current portfolio of EE/DR programs in keeping customer costs low***

- Including the EEDR programs in the power supply plan avoids significant purchased power and new construction costs, while ***also providing a very valuable hedge against fuel price risk and load forecast uncertainty***

- On a system resource portfolio basis, the ***cumulative benefits to customers of achieving our EE/DR targets amounts to $1.8 billion*** (present value) with positive cash flow savings within 3 years compared to a plan without this resource, all of which ***flows through directly to customers in the form of lower bills***