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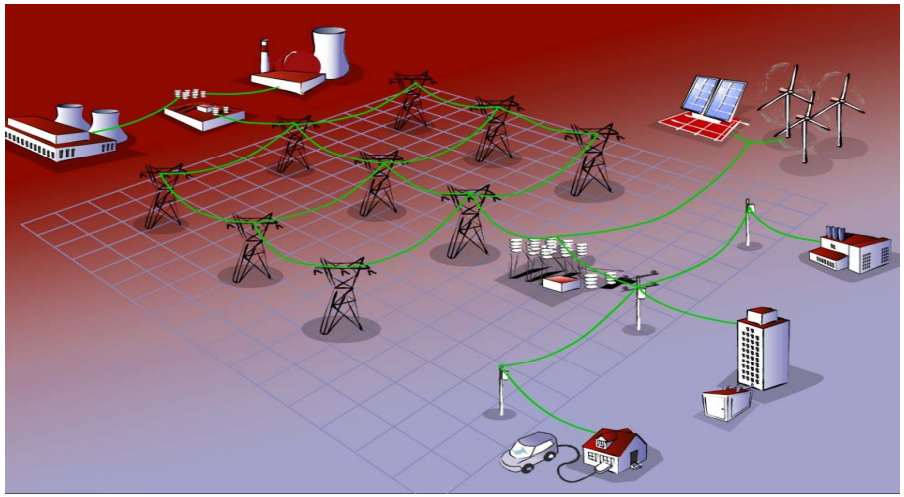

West Virginia Smart Grid Implementation Plan - Roadmap Framework

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GridWeek 2010

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Smart Grid Characteristics – Basis for the Roadmap

The Smart Grid is "transactive" and will:

- *Enable* active participation by consumers
- *Accommodate* all generation and storage options
- *Enable* new products, services and markets
- *Provide* power quality for the digital economy
- *Optimize* asset utilization and operate efficiently
- *Anticipate & respond* to system disturbances (self-heal)
- *Operate* resiliently against attack and natural disaster

…the enabler

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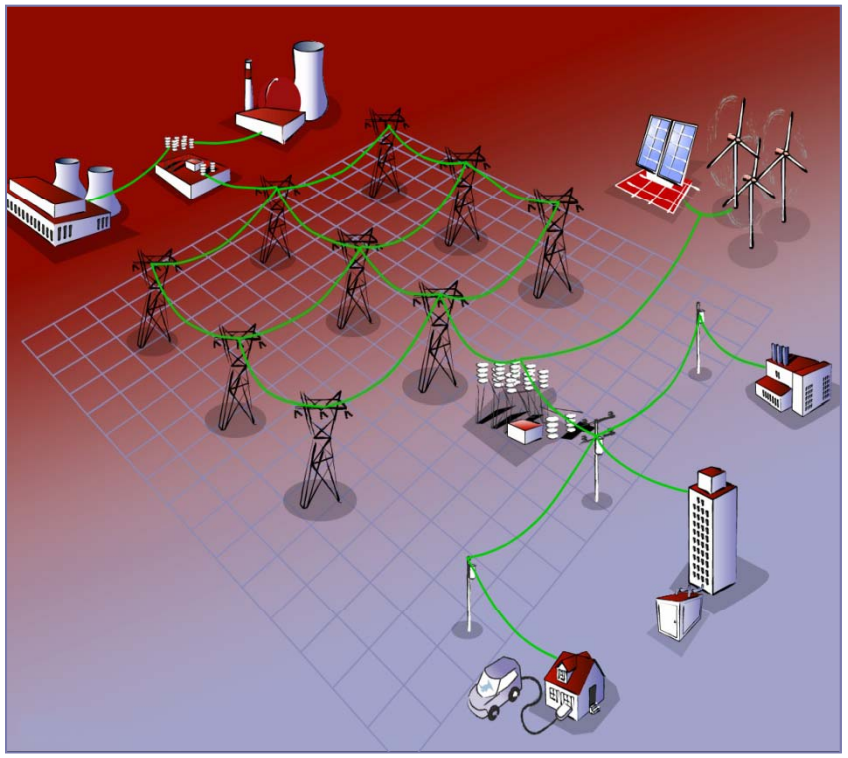
West Virginia Smart Grid Implementation Plan (WV SGIP)

If you don't know where you are going, you might wind up someplace else.

- Yogi Berra

West Virginia Smart Grid Implementation Plan

- Project jointly funded by NETL, SAIC, Allegheny Power, AEP, State of West Virginia, WVU, and DOE OE
- Results describe the approach and value proposition of implementing Smart Grid in West Virginia
- Cost & benefit analysis compare the state of current electricity grid and future Smart Grid in West Virginia
- Address the role of coal in Smart Grid
- Support economic development in State of West Virginia
- First state-wide Smart Grid implementation plan completed
- Second Smart Grid study to be published in the nation



Key Facts About West Virginia

- 991,000 electric customers (142,000 commercial and industrial)
- 16,500 MW of generation capacity (90% coal-fired)
- Over 47,000 miles of distribution circuits
- 5,900 miles of transmission lines
- 58M MWh traded outside the state
- 32M MWh used inside the state
- AEP and Allegheny Energy serve 98% of the customers
- SAIDI (with storms) = 439 min/customer/yr
- SAIFI = 1.52
- Storm SAIFI = 0.45
- NOx = 157K T/yr
- SOx = 456K T/yr
- CO2 = 87M T/yr

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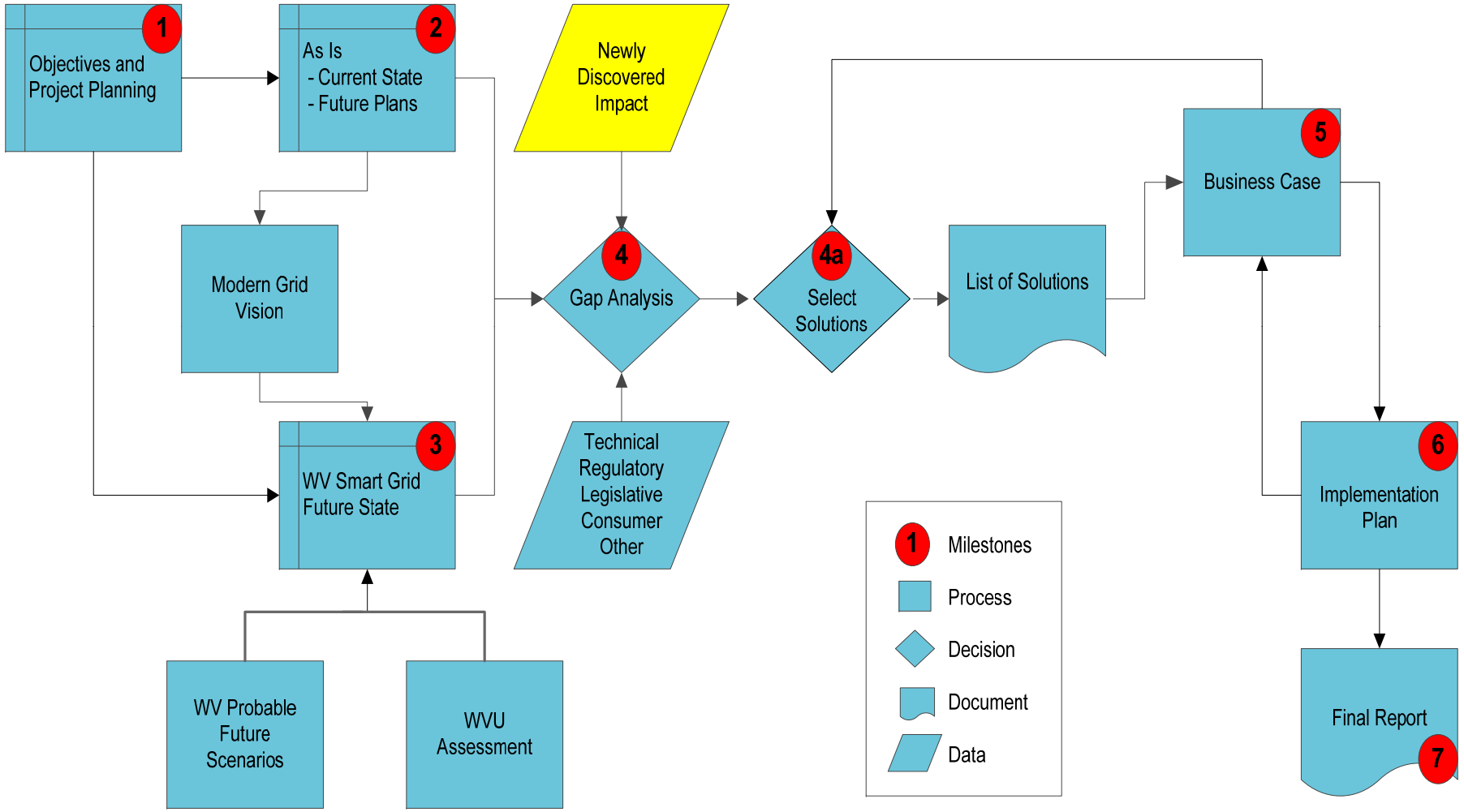
WV SGIP Framework

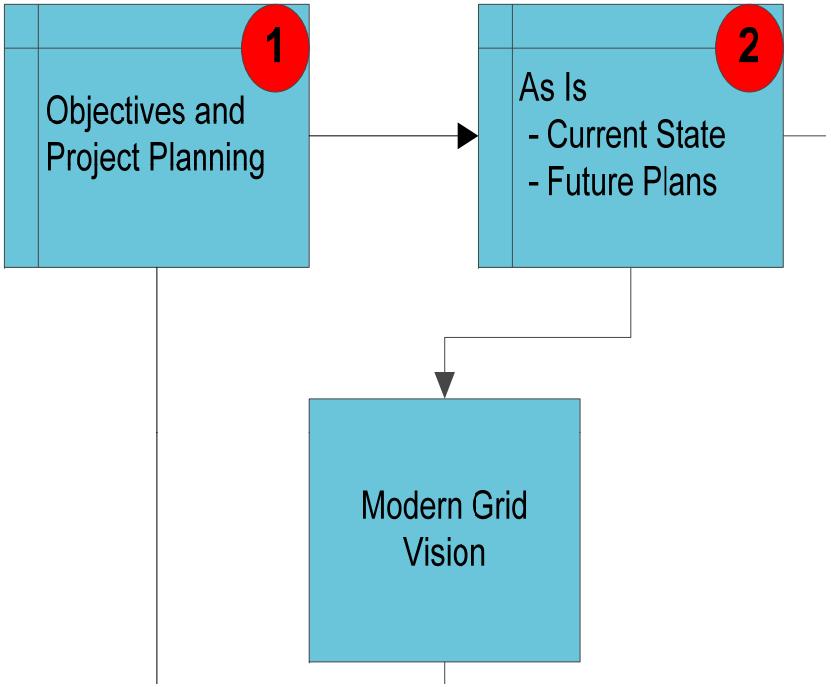
If you come to a fork in the road, take it.

- Yogi Berra

WV SGIP Framework



Milestone 1 and 2

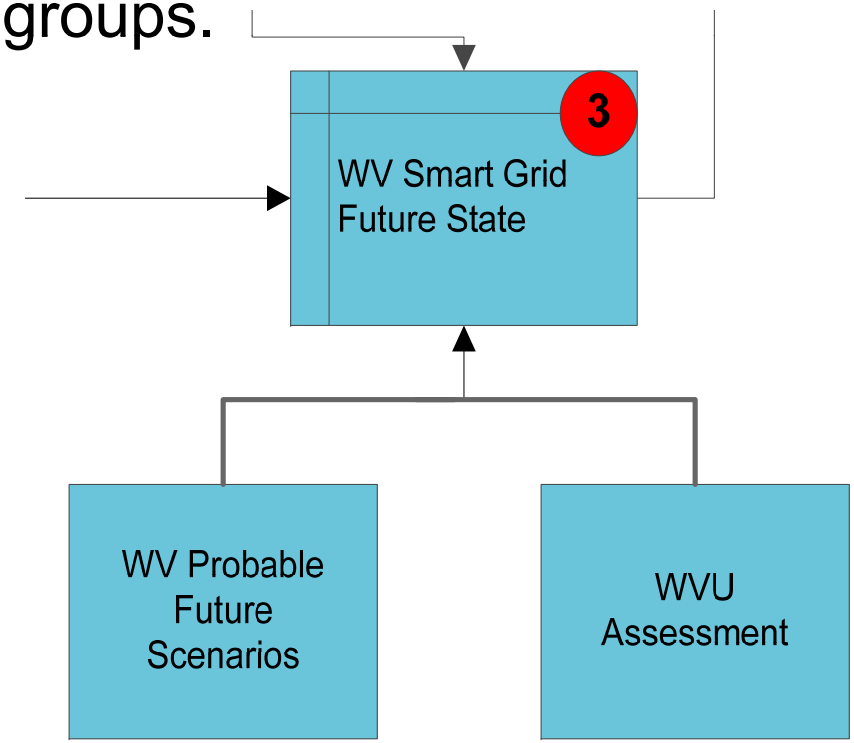


Milestone 1 – sets the agreed upon objectives of the work and establishes an overall plan to accomplish the project.

Milestone 2 – develop an understanding of the current state of the grid in West Virginia (WV) in relation to the stakeholder values associated with electric services in WV. This includes an assessment of the current state using the Smart Grid Characteristic Maturity Model.

Milestone 2

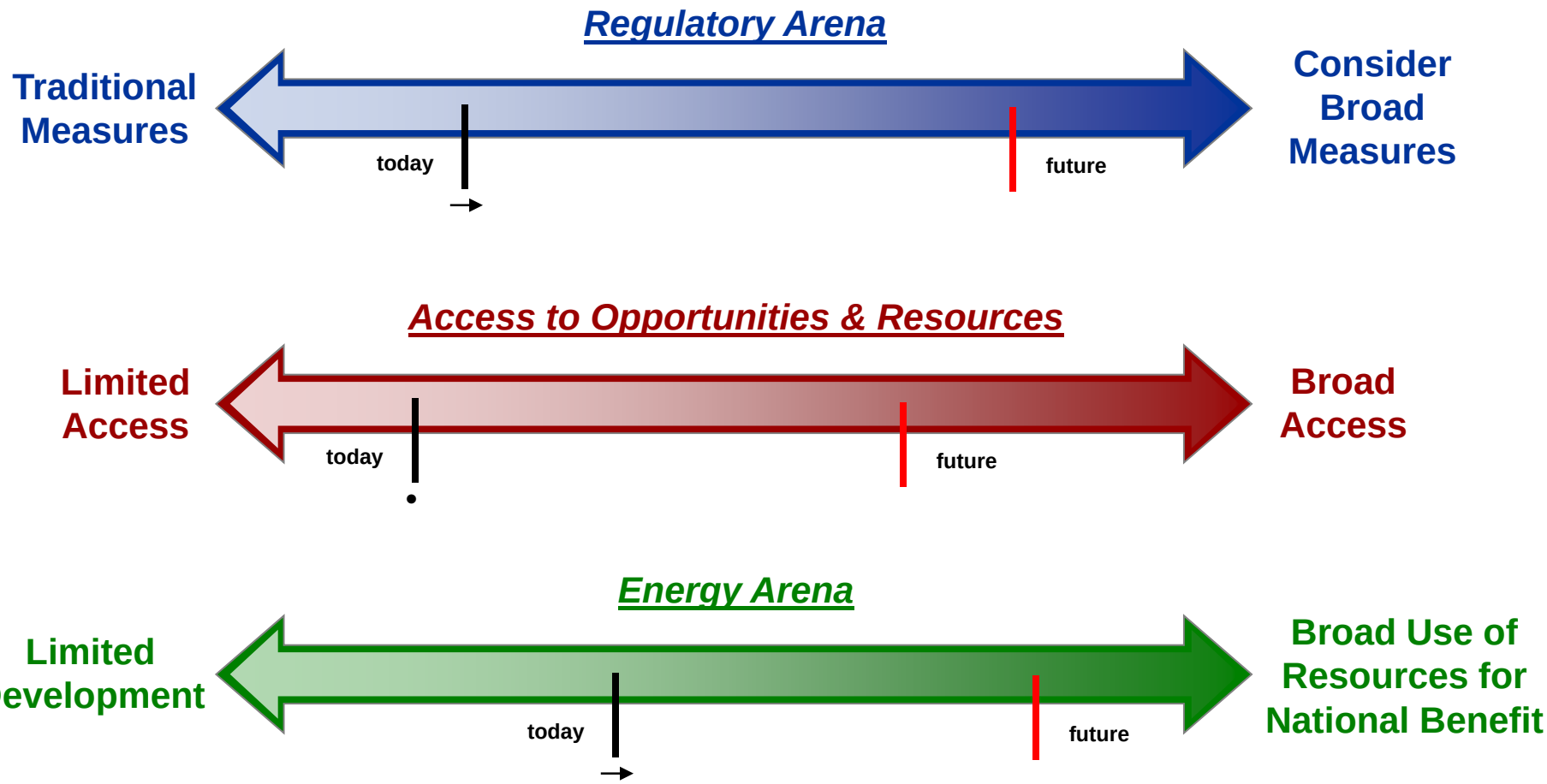
Milestone 3 – develop an understanding of the probable future state in WV given the objectives of the state, the national Smart Grid vision from the Modern Grid Strategy team, inputs from the Probable Future State Scenarios, and inputs from the West Virginia University (WVU) consumer and stakeholder focus groups.



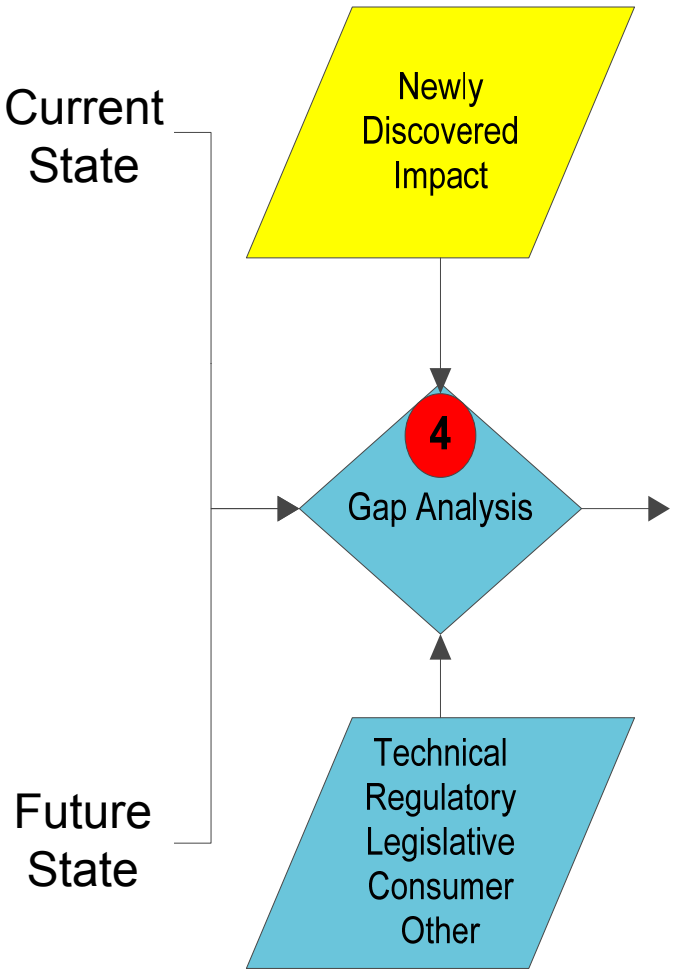
Probable Future State scenarios were developed around key dimensions of Regulatory Arena, Access to Opportunities and Resources, and Energy Arena.

This also includes an assessment of the probable future state using the Smart Grid Characteristic Maturity Model.

Probable Future States – Important Dimensions



Milestone 4

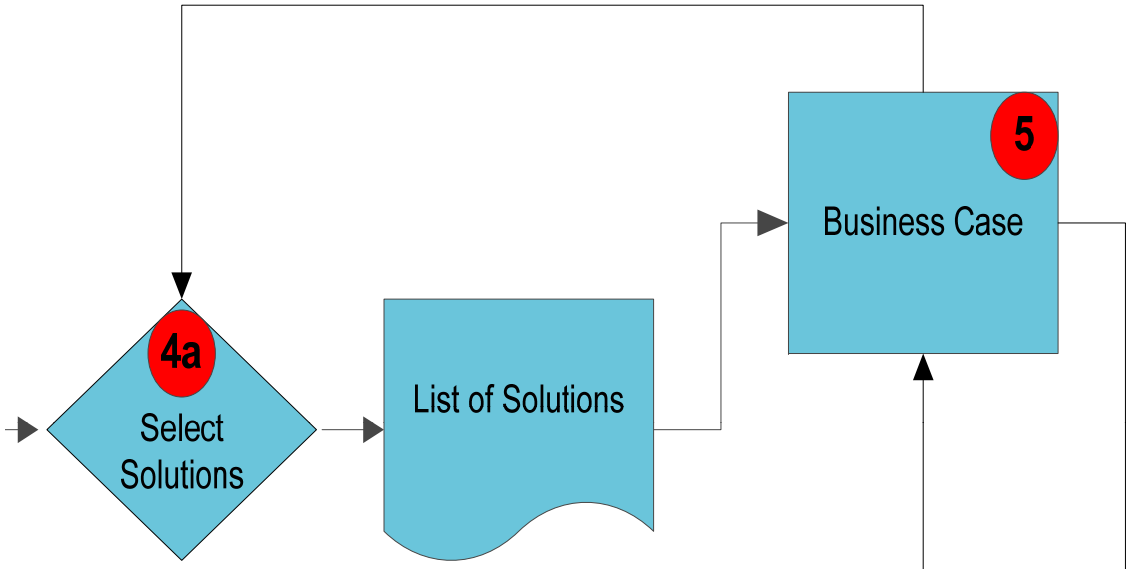


The information from Milestones 2 and 3 provide the essential information for the Gap Analysis or Milestone 4.

Milestone 4 – analyze the gap between the current state and the probable future state in the context (dimensions) of technology, regulatory / policy, and consumer needs.

The gap analysis suggests solutions (technology, regulatory, policy, and consumer) that will close the gaps.

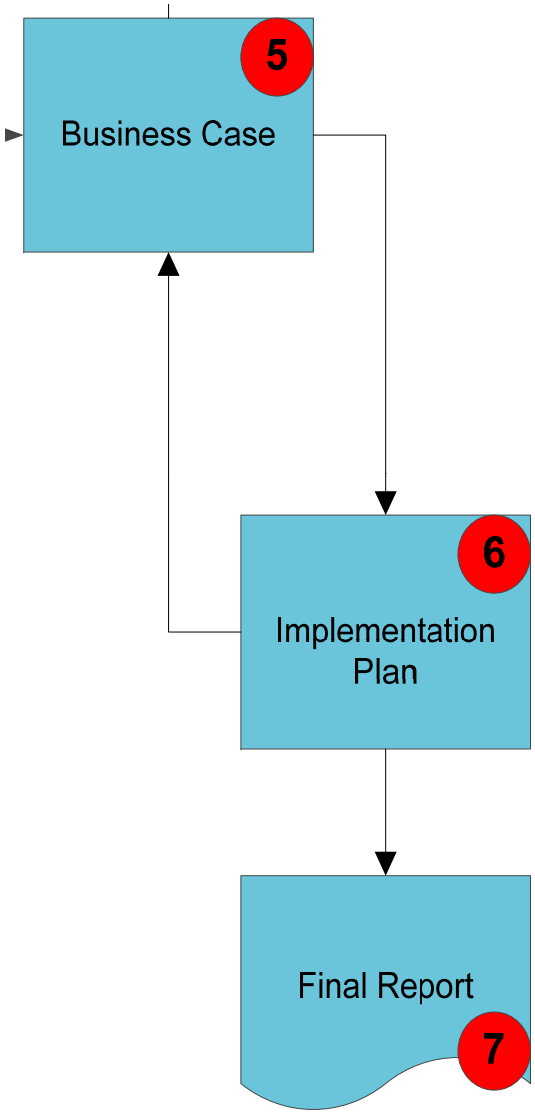
Milestones 4a and 5



Milestone 4a – determine the Solution Set that best address the gaps identified in the gap analysis.

Milestone 5 – develop the business case to analyze the costs to implement the solutions, and the benefits to utility operations, WV consumers, WV society, and regional U.S. society. This milestone is iterated with Milestone 4a to refine the scope of each solution to provide the most compelling business case for WV.

Milestones 6 and 7



Milestone 6 – from the solution set optimized by the business case, develop an implementation plan that is practical and deliverable. The implementation plan is iterated with Milestone 5 as sequencing and duration of each solution's implementation can affect the business case. This sequencing processing continues until a practical feasible solution is revealed or until all solutions are exhausted and the plan is deemed infeasible. At this point a final report results.

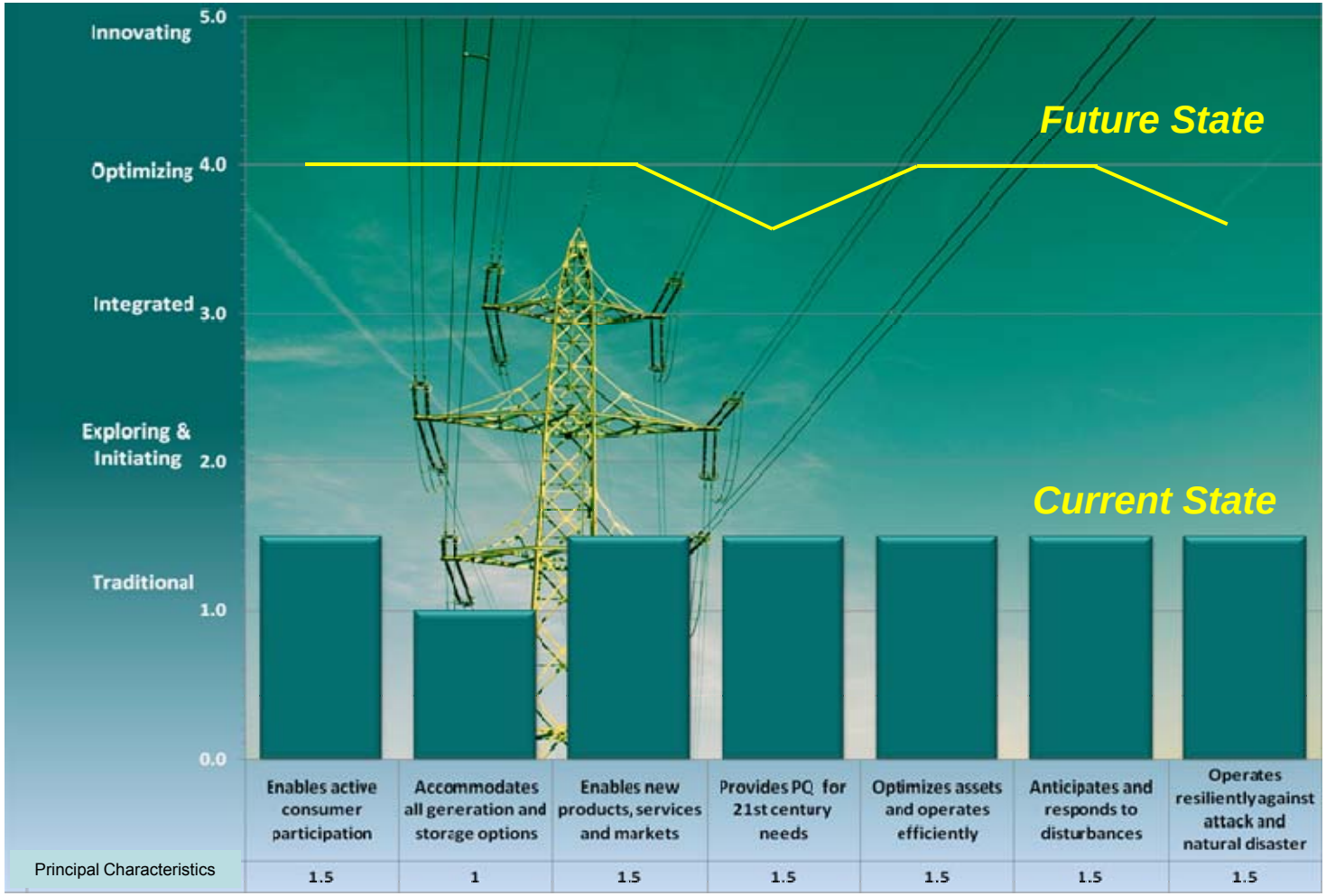
Milestone 7 – develop a report that documents the results of the process, the outcomes in the form of the business case and implementation plan, and presents the results to key stakeholders.

Final Results

It's pretty far, but it doesn't seem like it.

- Yogi Berra

WV Smart Grid Characteristic Maturity Evaluation*



**Based on the Smart Grid Maturity Matrix (SGMM) questions*

WV Smart Grid Solution Set

Solution	Scope
Advanced Meter Infrastructure (AMI)	All residential, commercial and industrial Customers represented by 998,317 meters
IT Integration (IT)	A CIS Upgrade to accommodate AMI and DR functionality & Outage Management
Demand Response (DR)	The aggregated sum of 104 MW of DR from Residential, Commercial and Industrial Customers
Distribution Management System (DMS)	The automated fault clearing and restoration of service, circuit monitoring and control of the Distribution System to include 707 circuits of 1107 total circuits
Distributed Energy Resources (DER)	100MW of Base Generation, 800 MW of Peak Generation, 250 MW of Advanced Storage and 100 MW of Wind Resources all capable of being dispatched on demand

Important Distinctions for WV

- **Reductions in WV consumption go to exporting more energy**
  - 104MW of DR, does not necessarily mean a reduction of generation. It likely means 104MW of increased export.
  - More efficient delivery system (reduced line losses) means more export.
- **Benefits from reduced WV outages is higher than most states**
  - Higher outage parameters (number and duration) are the overriding benefit potential of a WV Smart Grid

WV Smart Grid Costs & Benefits

	PV 20-yr Cost and Benefits ($M)	
Solution	**Cost**	**Benefits**
AMI	$399	$1,649
IT	$170	$1,308
DR	$22	$1,091
DMS	$454	$3,288
DER	$832	$5,289
Total	**$1,878**	**$12,625**

Benefit to Cost Ratio for West Virginia 5:1
Benefit to Cost Ratio for San Diego 6:1
Benefit to Cost Ratio for US (EPRI, 2004) 4:1 to 5:1

WV Benefits by Beneficiary

	PV 20-yr Benefits by Beneficiaries ($M)			
Solution	**Consumer**	**Operational**	**WV Society**	**US Society**
AMI	$630	$439	$308	$271
IT	$563	$136	$326	$283
DR	$23	$614	$240	$214
DMS	$2,909	$73	$303	$2
DER	$3,368	$2	$301	$1,618
Total	**$7,493**	**$1,263**	**$1,479**	**$2,389**

WV Annual Benefits ($M)

Key Success Factors	Benefits	Annual Benefits ($M) (All Beneficiaries)
Reliability	Reduced Consumer Losses	$898
	Reduce Power Quality Events	$131
Economic	Reduce Price of Electricity	$399
	Job Creation	$215
	Consumer Sales of DER Resources	$175
	Increased Energy Sales as Exports	$7
	Reduced Transmission Congestion	$1
	Increased Transportation Fuels Business	$5
	Consumer Conservation	$20
	Operational Savings	$194
Environmental	Reduced Emissions	$7
Security	Reduced Blackout Probability & Dependence on Foreign Oil	$13
Safety	Reduce Hazard Exposure	$1

Conclusions

- **Implementing a Smart Grid will:**
  - Radically improve system reliability
  - Lower the carbon footprint
  - Support a better sustainable business climate
  - Generate benefits beyond the borders
- **WV "numbers" (20-yr present value)**
  - ~ 1 million meters
  - Total Smart Grid Cost - ~ $1.9B
  - Total Smart Grid Benefit - ~ $10B
  - Benefit Cost Ratio: 5:1
- **A Smart Grid can be implemented with a portion of the business as usual (BAU) 10-year capital plan.**
- **A WV Smart Grid benefits the regional market (others outside the state benefit greatly)**

For More Information

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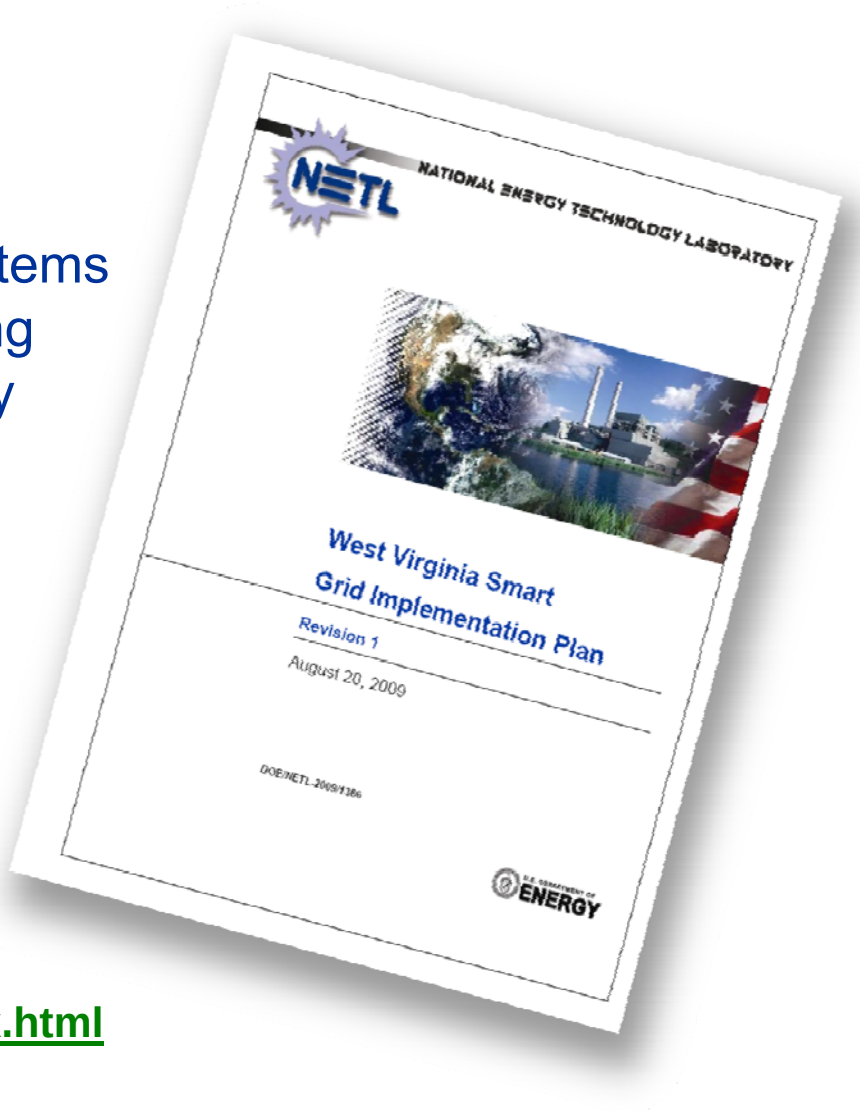

For additional Information:

http://www.netl.doe.gov/energy-analyses/index.html