

Overview: Models for Energy Forecasting

Presented at:

20th Meeting of the CAREC Energy Sector Coordinating Committee

Kuala Lumpur, Malaysia 7-10 September 2015



Topics of Discussion

- 1. Energy Planning Tools
- 2. CAREC Modeling Requirements
- 3. Demand Forecasting Models
- 4. Risk Informed Decision Making



Energy System Planning Tools

Туре	Approach	Typical Application	Typical User
Energy Demand	Top Down vs Bottom Up	 Prepare energy demand forecasts Forecast hourly electricity demand 	Energy Ministry Utility Research Institute
Electricity System Expansion	Simulation vs Optimization	 Develop power expansion plan Compute environmental burdens from electricity generation 	Energy Ministry Utility Research Institute
Electricity System Operation	Regulated utility vs markets	 Optimize system operations Evaluate regional energy exchange and renewable energy integration 	Utility
Energy System	Simulation vs Optimization	 Energy and environmental policy analysis 	Energy Ministry Research Institute

Tools should be USEFULL, USABLE and USED

CAREC Energy Work Plan Focuses on Six Key Elements:

- 1. Developing the Central Asia-South Asia Energy Corridor
- 2. Resolving regional energy dispatch and trade issues
- 3. Managing energy-water linkages
- 4. Mobilizing funds to build energy assets
- 5. Implementing energy priority projects
- 6. Building capacity and managing knowledge.

EWP initiatives can be accelerated through use of common tools for analyzing energy options

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ENERGY DEMAND MODELS

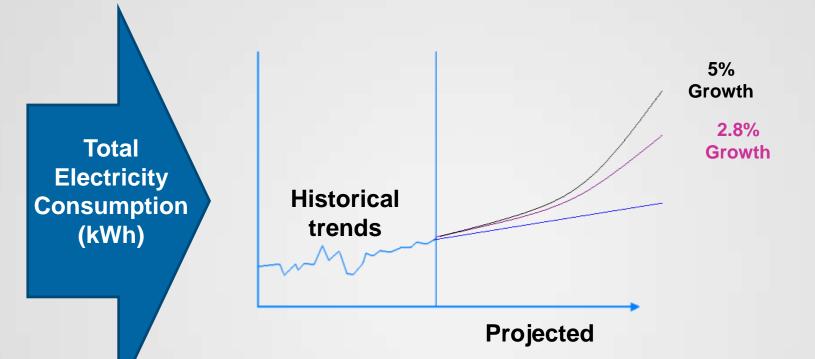
Top down approach

- Grounded in economic theory
- Statistical analysis of historical data is used to understand relationships between energy and economic variables (e.g., price and income)

Bottom up approach

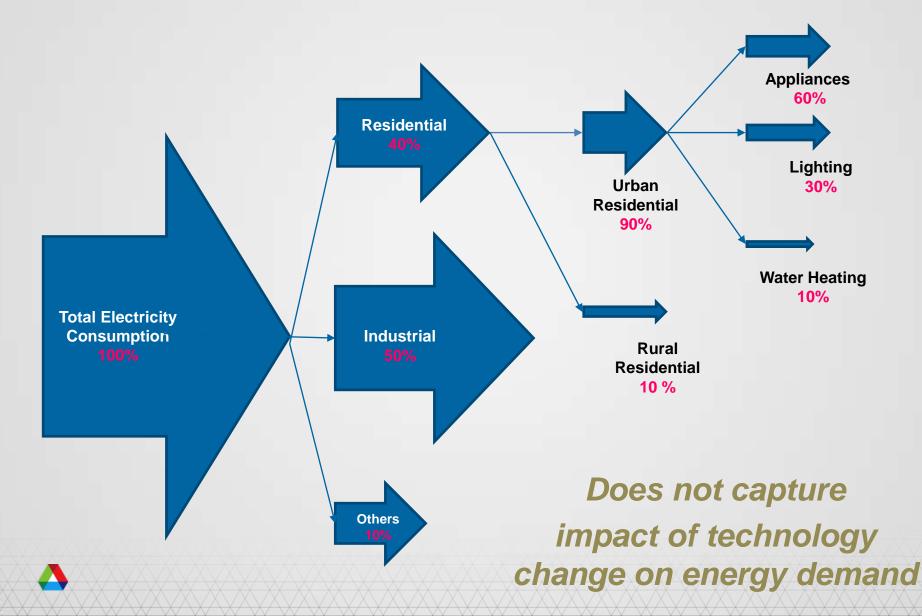
- "end-use" or "engineering-economic" method
- focuses on analyzing end-uses or final energy needs at a disaggregated level (e.g. sectors)

TOP DOWN PROJECTIONS

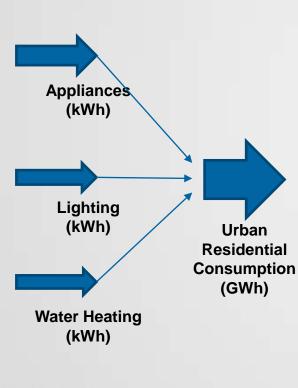


- Historical analysis of total energy consumption
- Correlate energy consumption to "driver variables" such as GDP, Population, and Price
- Apply growth rates to forecast total electricity demand for a range of scenarios

TOP DOWN PROJECTIONS CAN BE DISAGGREGATED BY DISTRIBUTION

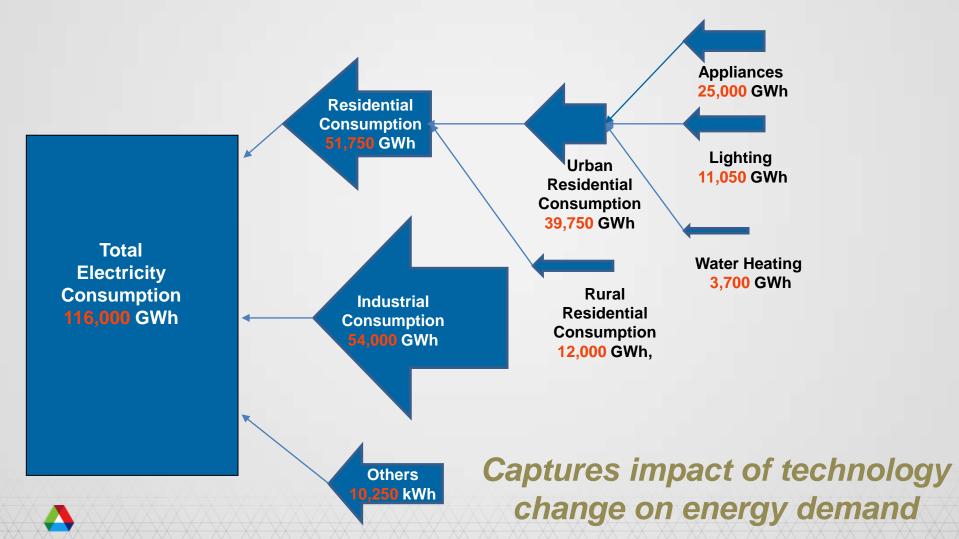


BOTTOM UP PROJECTIONS START FROM THE DETAILS OF ENERGY USE



	Current	2010	2015	2020	2025					
Service Provided										
Number of Urban Households (millions)	8.98	9.39	10.07	10.82	11.53					
Energy Intensities										
Appliance Electricity Use (kWh per household)	2818	2819	2822	2824	2826					
Lighting Electricity Use (kWh per household)	1201	1200	1180	1160	1140					
Water heating Electricity Use (kWh per household)	408.5	405	402	400	400					
Total Urban Residential Electricity Use (GWh)	39759	41541	44348	47435	50340					

BOTTOM-UP PROJECTIONS COMPUTE TOTAL CONSUMPTIONS AS THE SUM OF RESULTS FOR EACH COMPONENT



World Bank Report on "Energy Demand Models for Policy Formulation"

Criteria	DTI	MAED				
Туре	Top-Down	Bottom-Up				
Approach	Econometric	End-Use				
Level of Disaggregation	Industry, residential, transport, commercial, other	Electricity, industry, residential, transport, commercial, other				
Technology coverage	Conventional and Renewable	Conventional and renewable				
Skill required	High – Econometric Analysis	Low				
Versatility	Low – country specific	High – general model				
Portability	Difficult	Easy				
Documentation	Limited	Excellent				
Capability to analyze pricing policies	High	Does not exist				
Capability to analyze non-price policies	Good	High				
Rural Energy	Not covered separately	Can be included				

MAED

MODEL FOR THE ANALYSIS OF ENERGY DEMAND

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Distribution:

- Newest version developed by IAEA
- Distributed for use in over 107 countries and 12 international/regional organizations

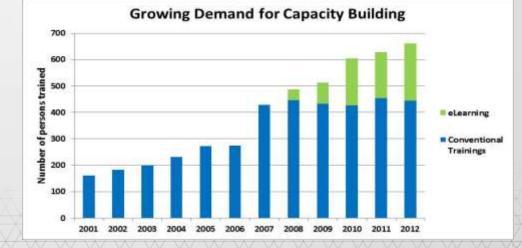
Associated Cost:

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Free to government and public sector organisations, research and non-profit institutions, and international/regional organizations

Training:

- National and regional training events
- eLearning helps satisfy growing demand



Topics of Discussion

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- **3.** Demand Forecasting Models
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Rock Falls, Illinois, USA, Natural Gas Power Plant



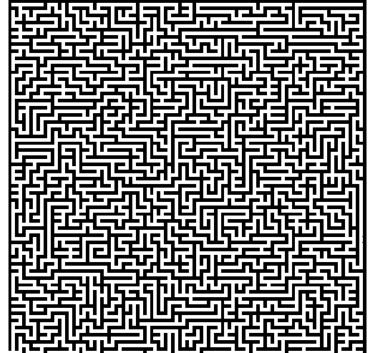
Risks are difficult to quantify, therefore Risks are difficult to incorporate into Energy Plans





Risks to Energy Master Plans "What can go wrong?"

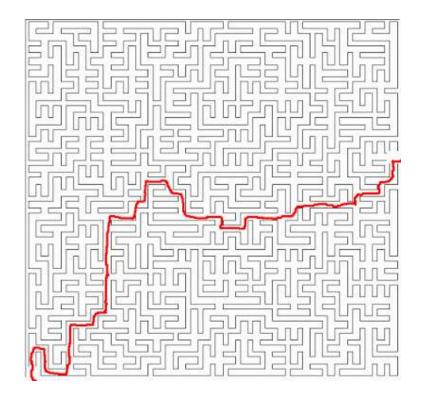
- Many different categories:
 - Institutional failures
 - Organizational failures
 - Operational failures
 - Governance failures ...
- Many different types of risk:
 - Inability to secure financing



- Policy/Regulation limits energy deployment
- Too much environmental damage
- Schedules are delayed and raise costs of deployment ...

There are many, many paths that can go wrong !

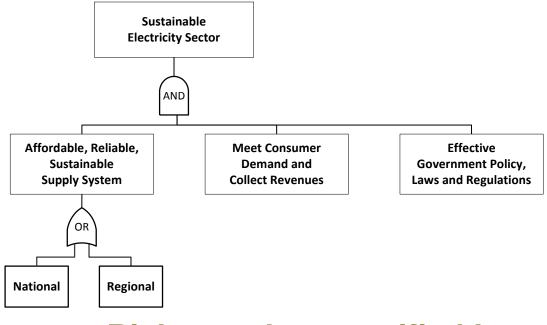
A "Successful" way to Assess Risk "What must go right?"



There are a manageable number of steps that must go right !

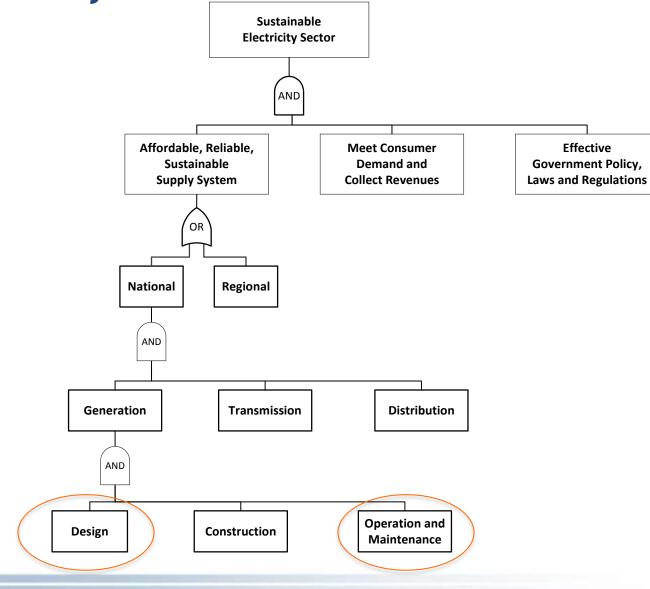
Using "Success Paths"

- Identify steps that "must" happen correctly
 Draw these steps under an "AND" gate
- Identify "choices" that must be made
 - Draw these steps under an "OR" gate



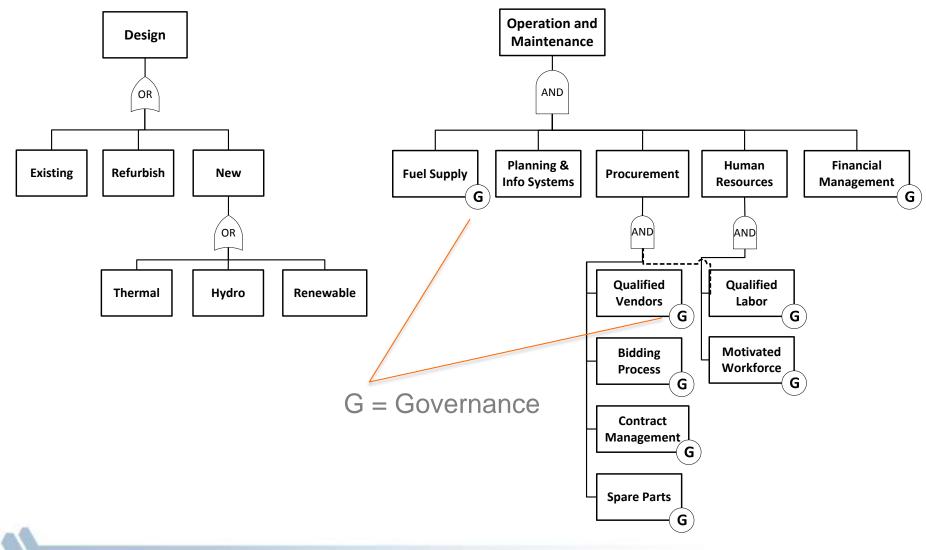
Risks can be quantified !

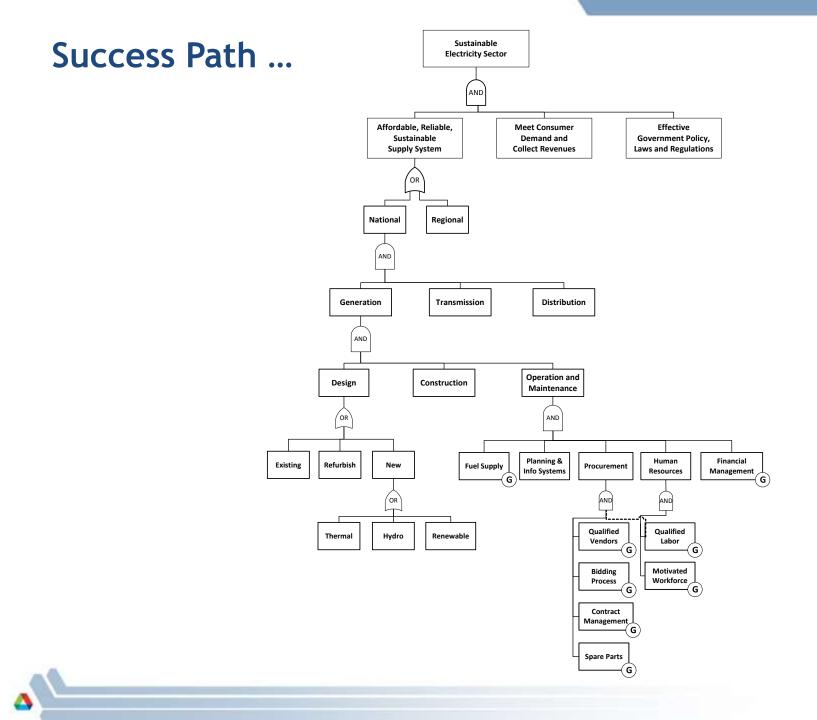
Building the success path for a National Electricity Sector



1

Building the success path for Design, Operations, and Maintenance





Risk Informed Decision Making Approach for National Energy Forecasting and Planning

- Listen to the stakeholders!
- Use success paths to diagram/communicate the risks
- Use success paths to obtain agreement between stakeholders
- Conduct detailed individual interviews with stakeholders to assess risk probabilities
 - Incorporate into the success path
 - Calculate risks for different options



- Use risk insights to refine energy modeling assumptions
 - E.g. (technology options, fuel supply options, ...)

A Master Plan designed to successfully manage risk!

Tarakhil Power Plant, Afghanistan



Four Problems at Tarakhil:

Demand

- Did not characterize planned Regional Interconnection that lowered demand
 - New power transmission system now supports Kabul
 - Did not "listen" to stakeholders
- Design (diesel technology)
 - Too expensive relative to other technologies
- Construction
 - Inefficient, multiple contractors (expensive)
- Operation and Maintenance
 - Complex fuel system: expensive and limiting

A Risk Informed Approach would have made a difference

Thank you for your attention

