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

Type	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

Topics of Discussion

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

ENERGY DEMAND MODELS

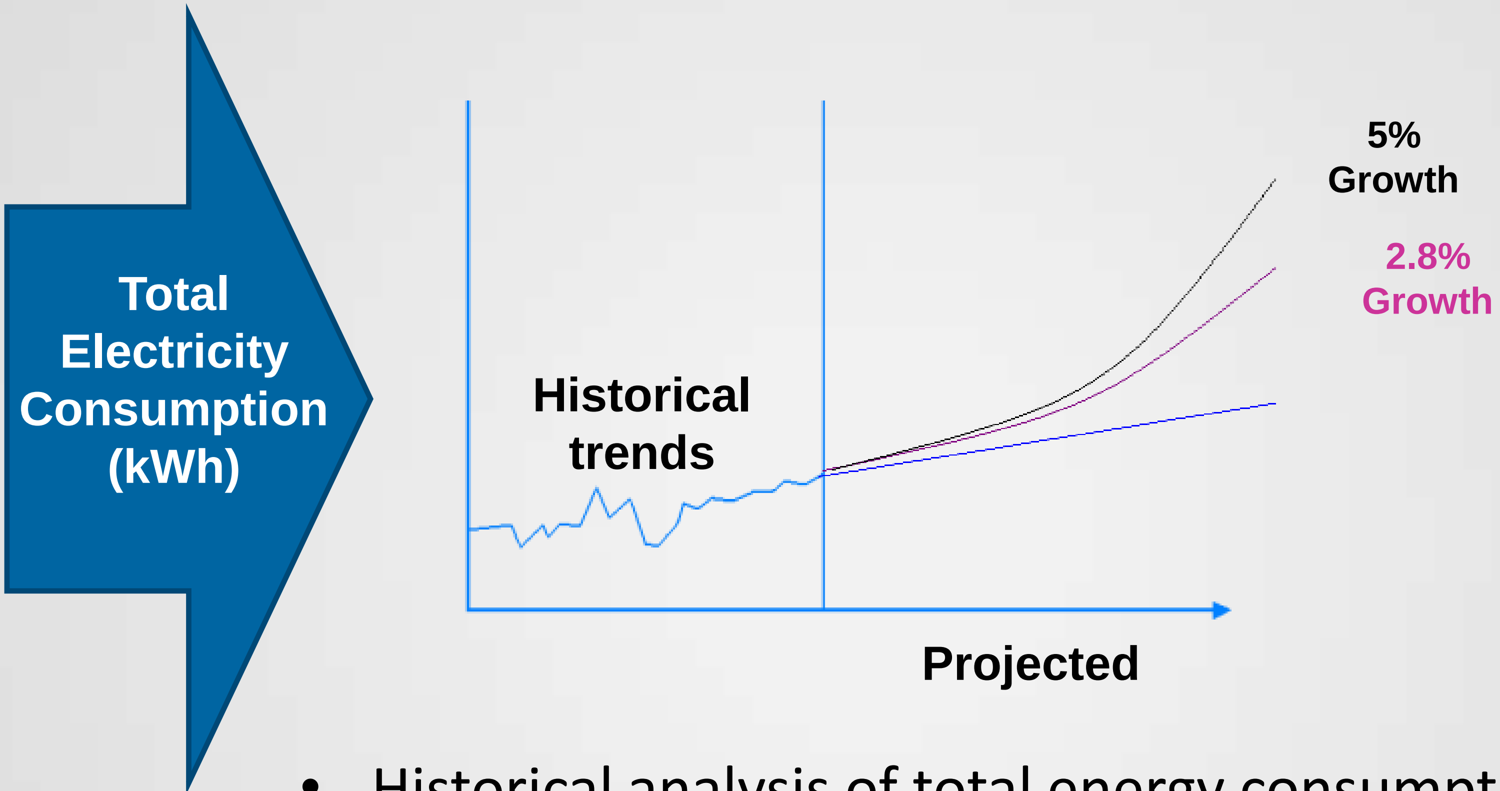
Top down approach

- 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

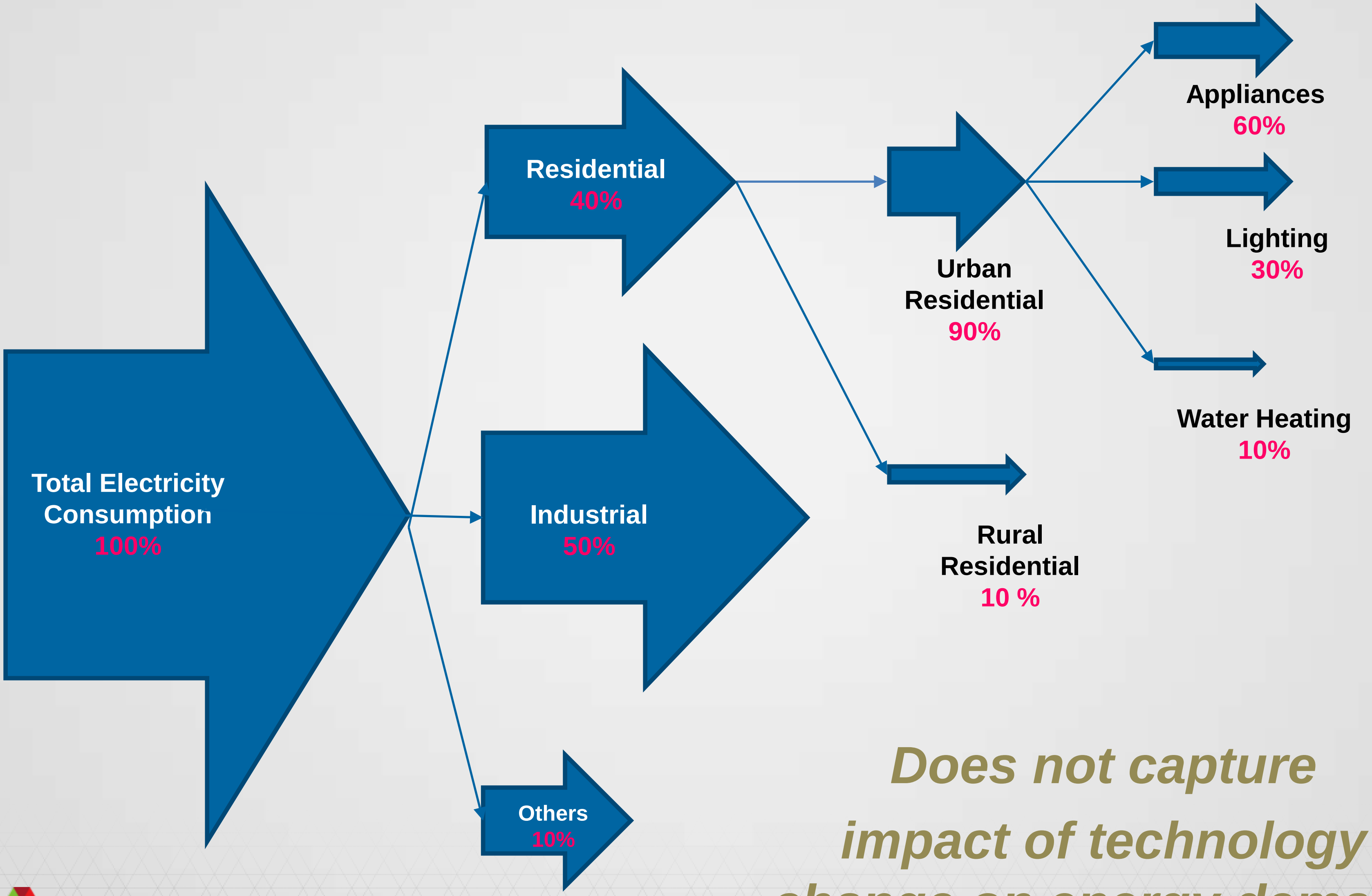
- "end-use" or "engineering-economic" method
- focuses on analyzing end-uses or final energy needs at a disaggregated level (e.g. sectors)

TOP DOWN PROJECTIONS



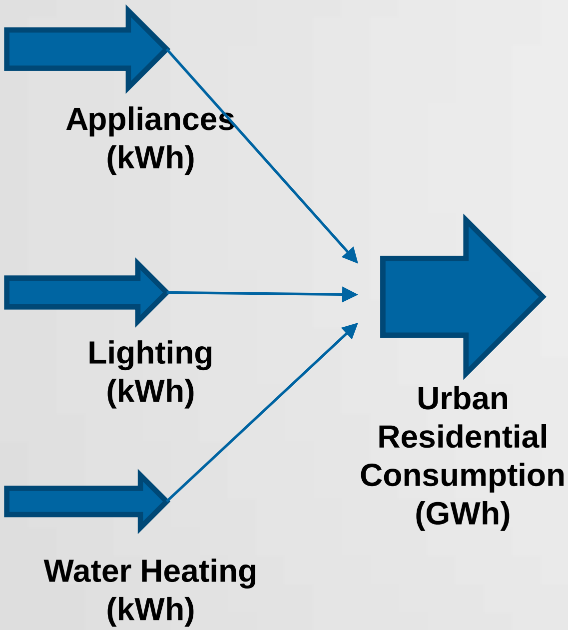
- Historical analysis of total energy consumption
- Correlate energy consumption to “driver variables” such as GDP, Population, and Price
- Apply growth rates to forecast total electricity demand for a range of scenarios

TOP DOWN PROJECTIONS CAN BE DISAGGREGATED BY DISTRIBUTION



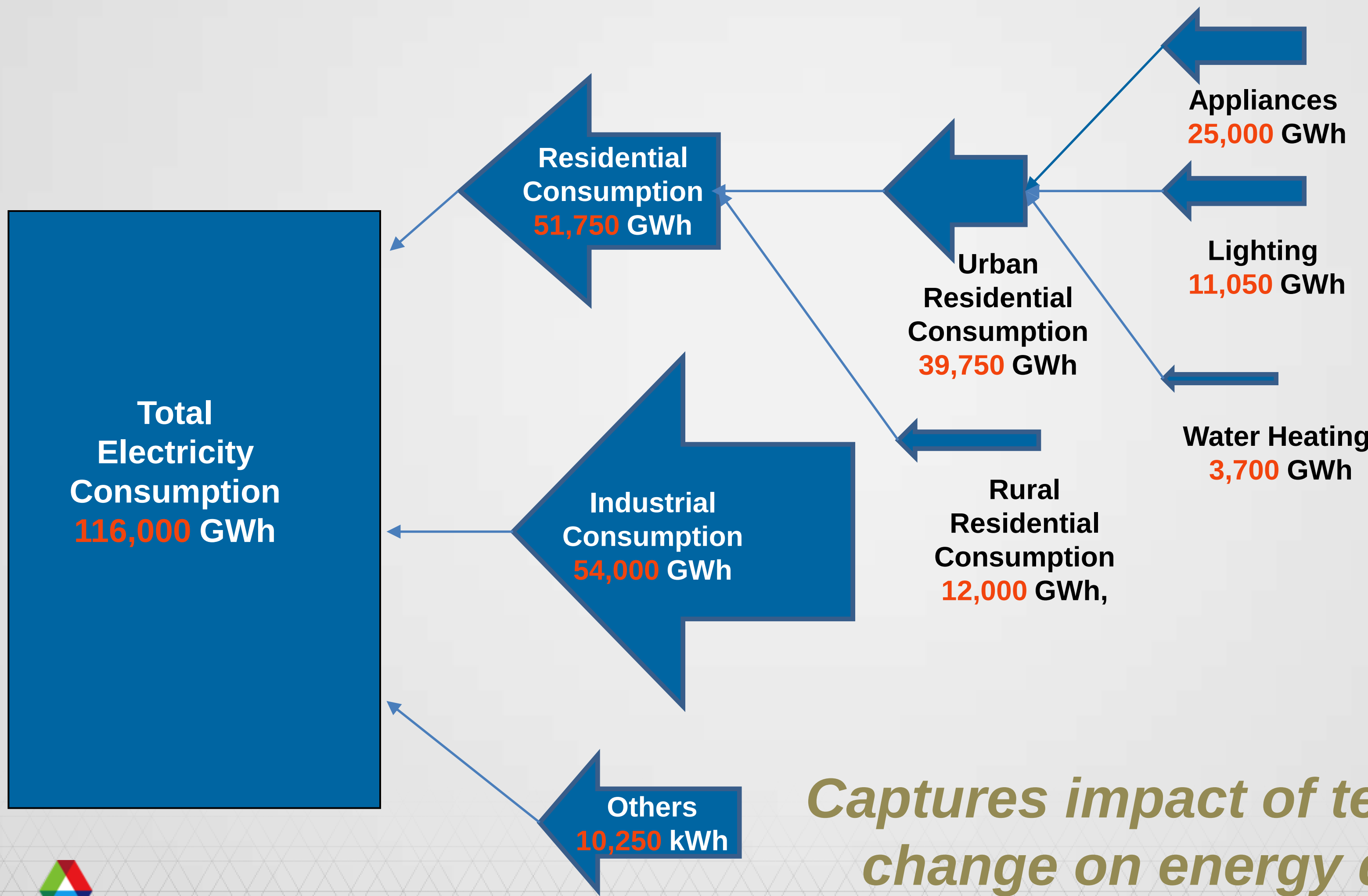
Does not capture impact of technology change on energy demand

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



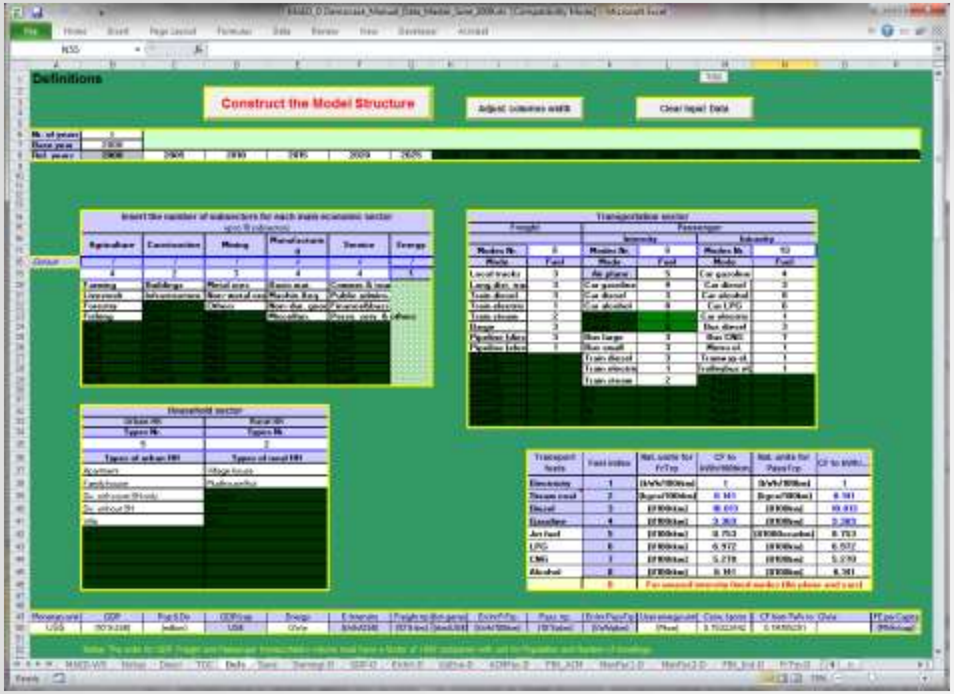
Captures impact of technology change on energy demand

World Bank Report on “Energy Demand Models for Policy Formulation”

Criteria	DTI	MAED
Type	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

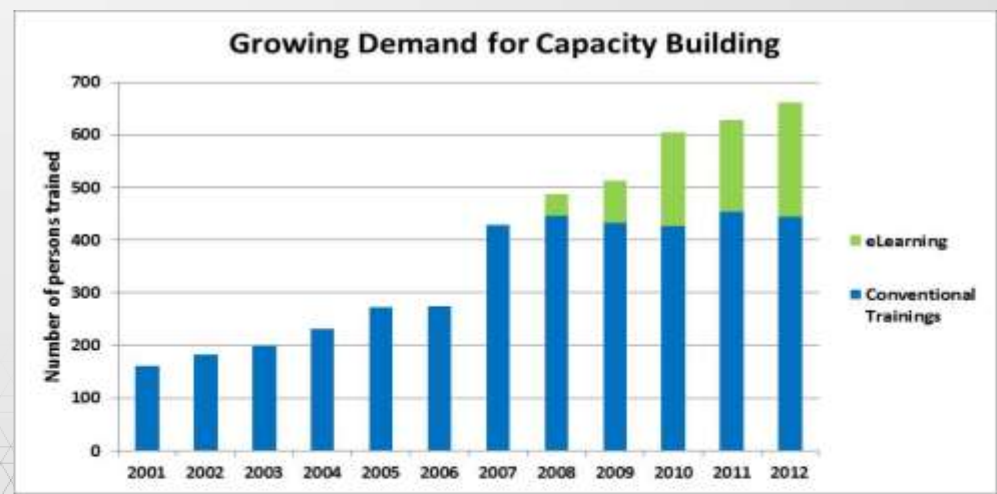


Distribution:

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

Associated Cost:

- 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

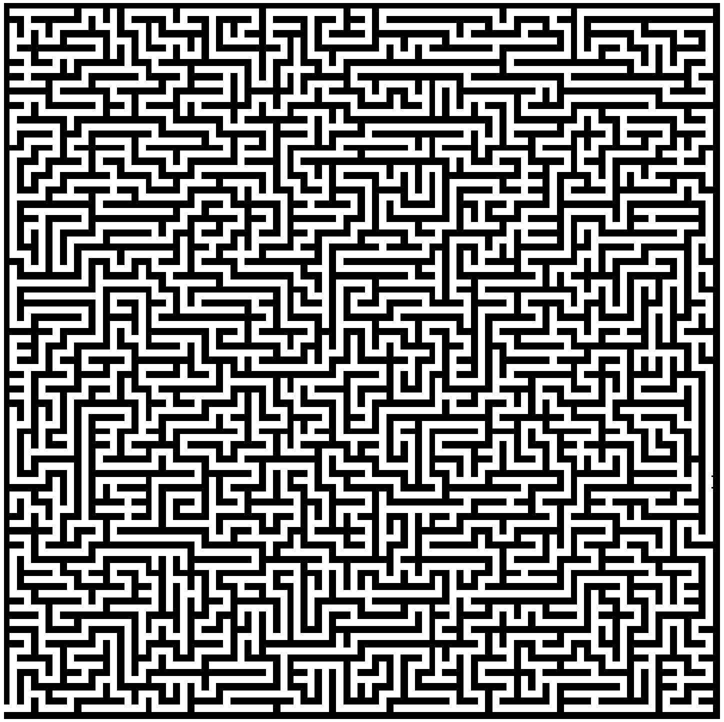
1. Energy Planning Tools
2. CAREC Modeling Requirements
3. Demand Forecasting Models
4. Risk Informed Decision Making

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

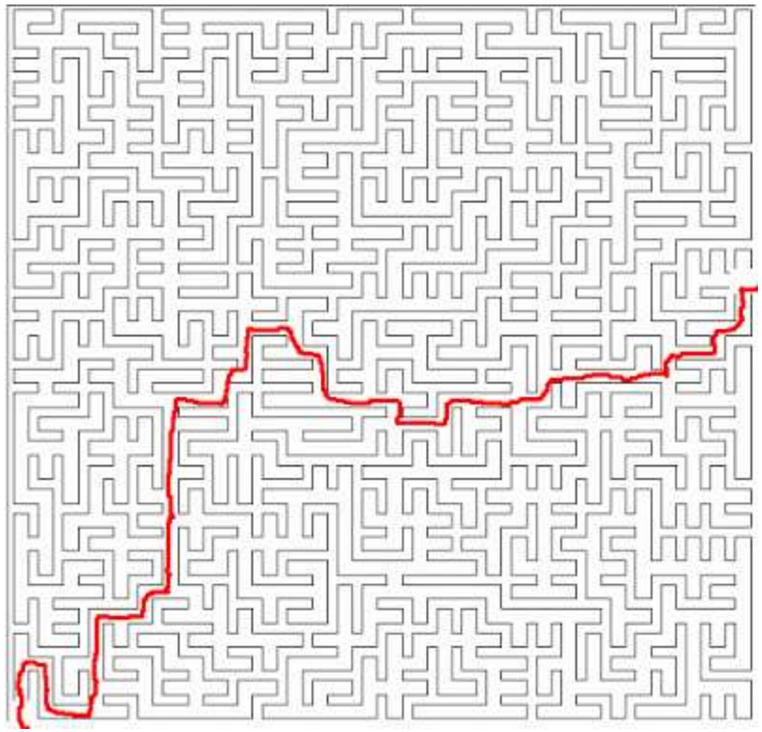
“What can go wrong?”



- 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 !

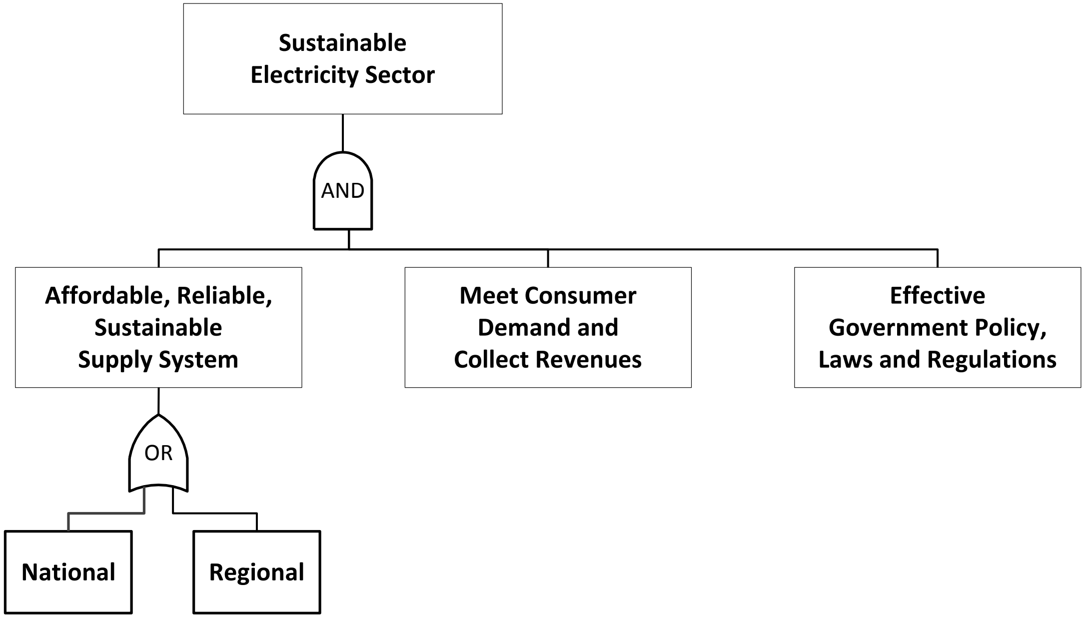
A “Successful” way to Assess Risk
“What must go right?”



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

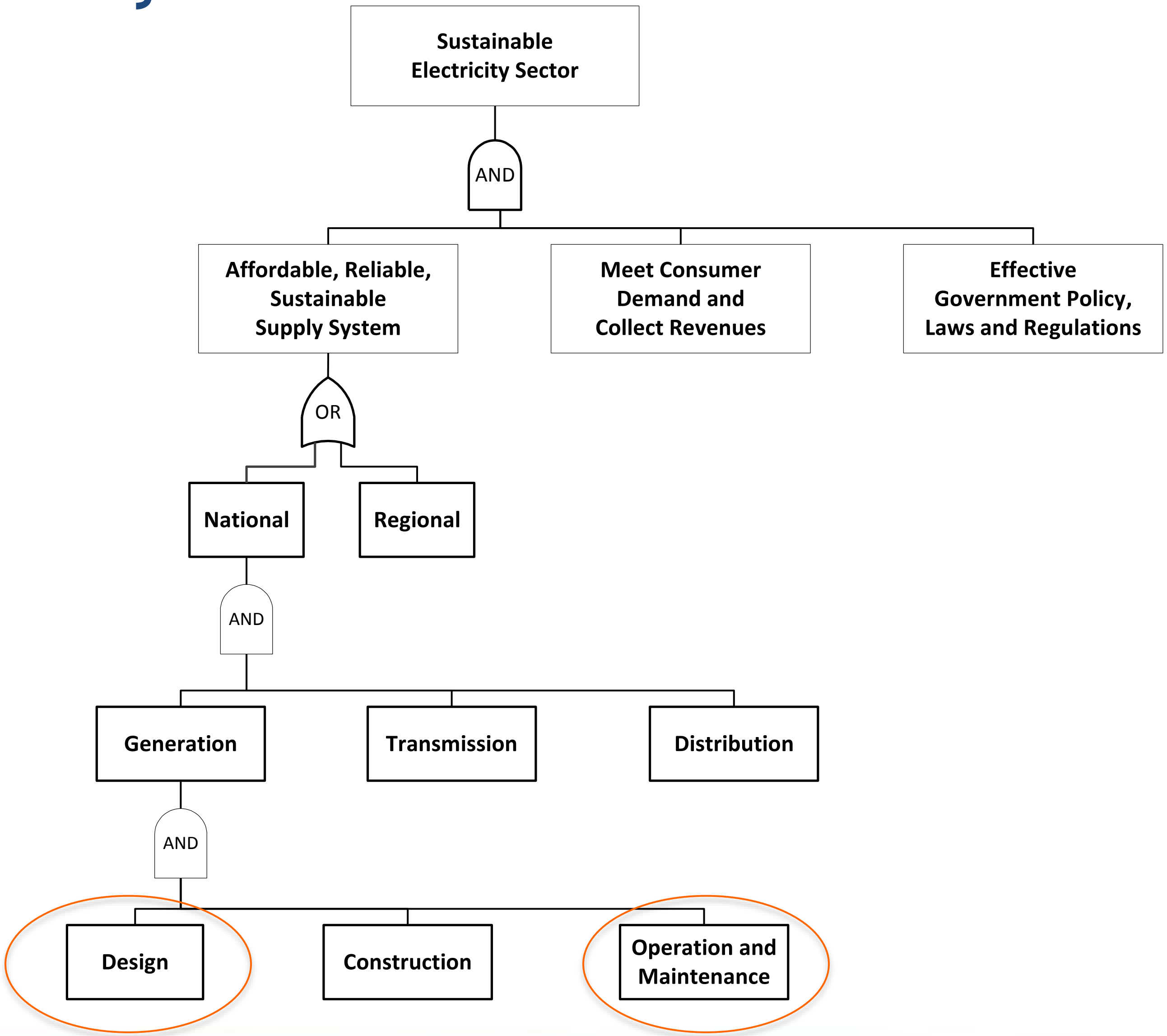
Using "Success Paths"

- 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

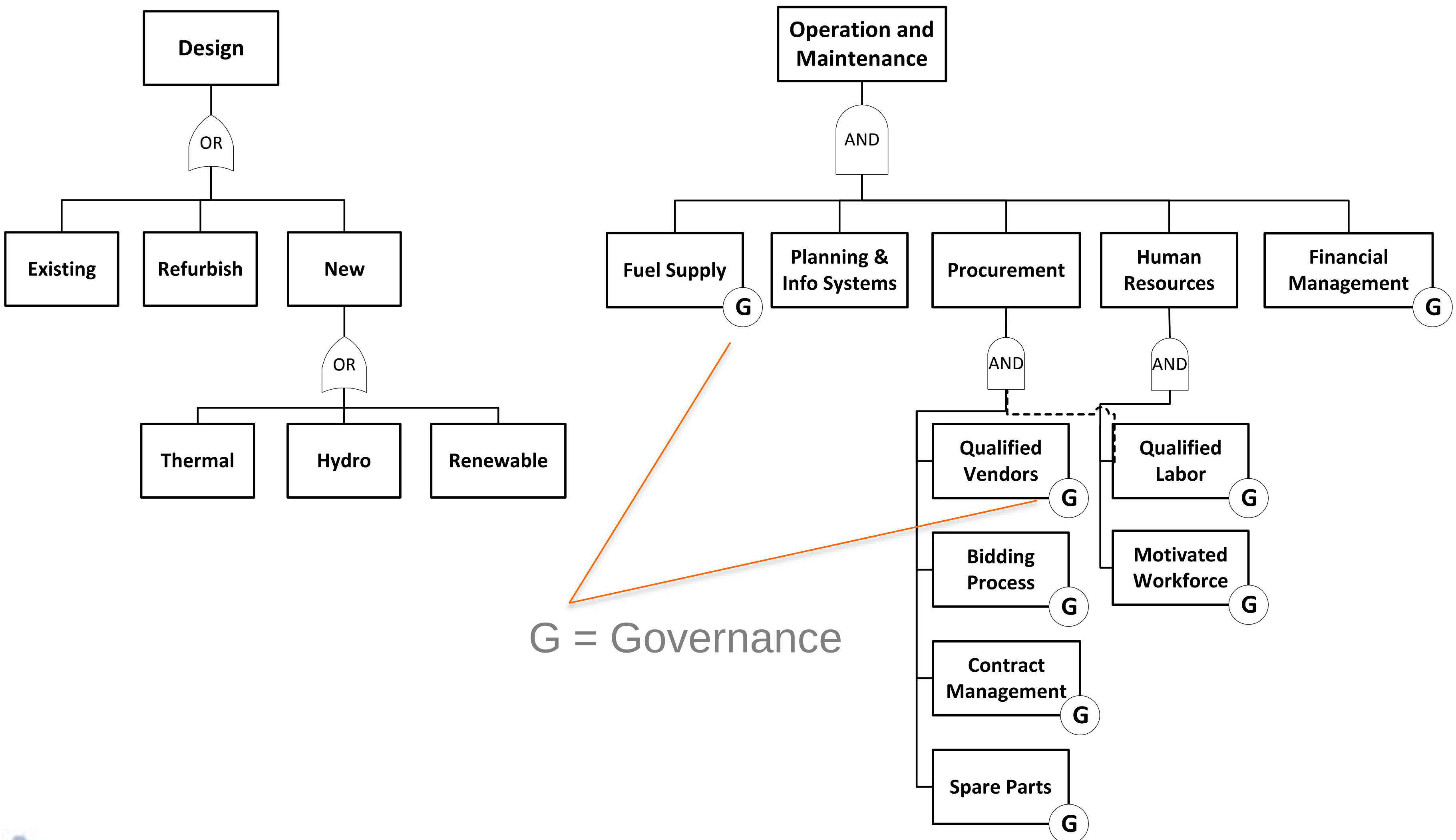


Risks can be quantified !

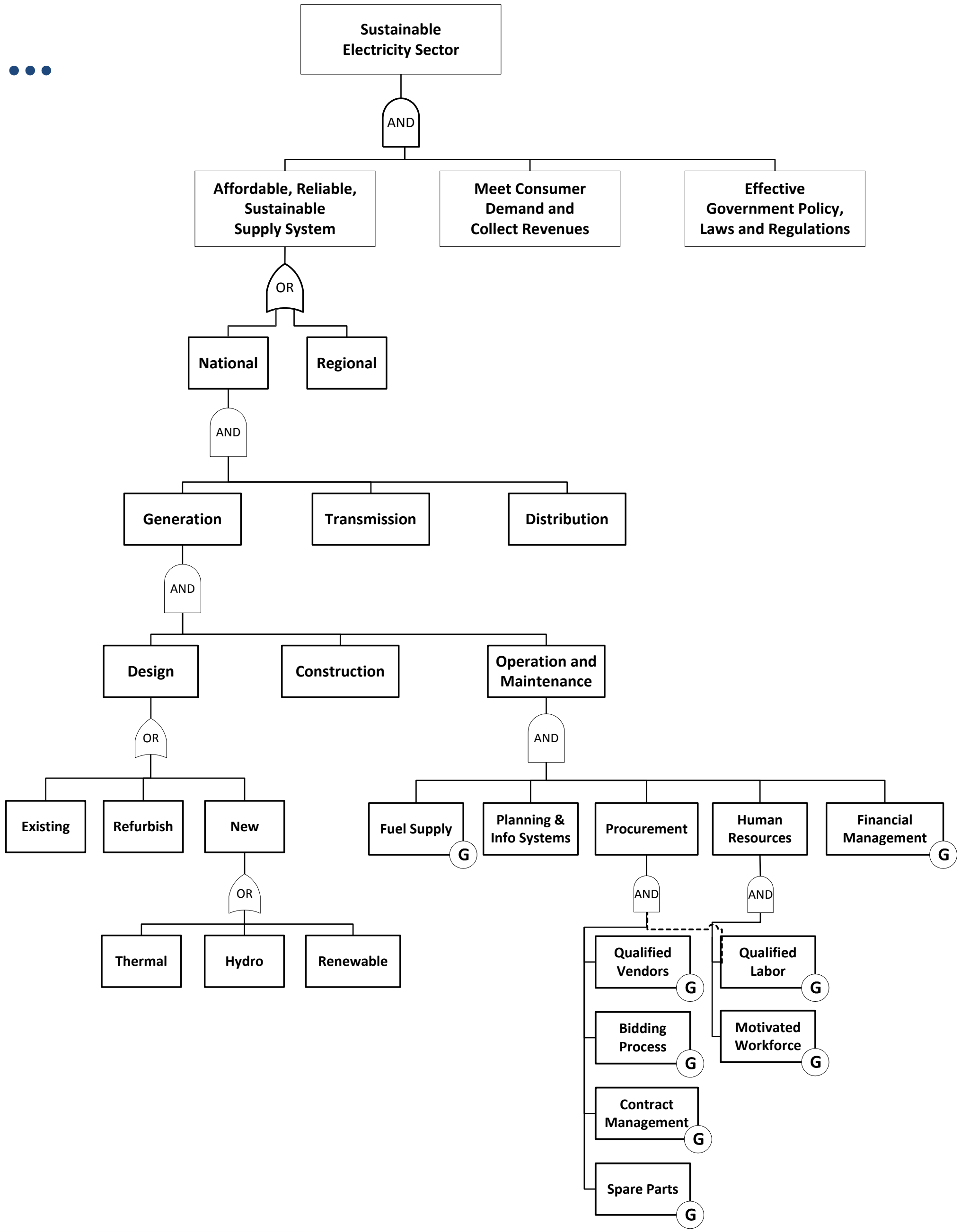
Building the success path for a National Electricity Sector



Building the success path for Design, Operations, and Maintenance



Success Path …



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