Integrated Resource & Resilience Planning (IRRP) for the Power Sector

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Session 3: Scaling an IRRP

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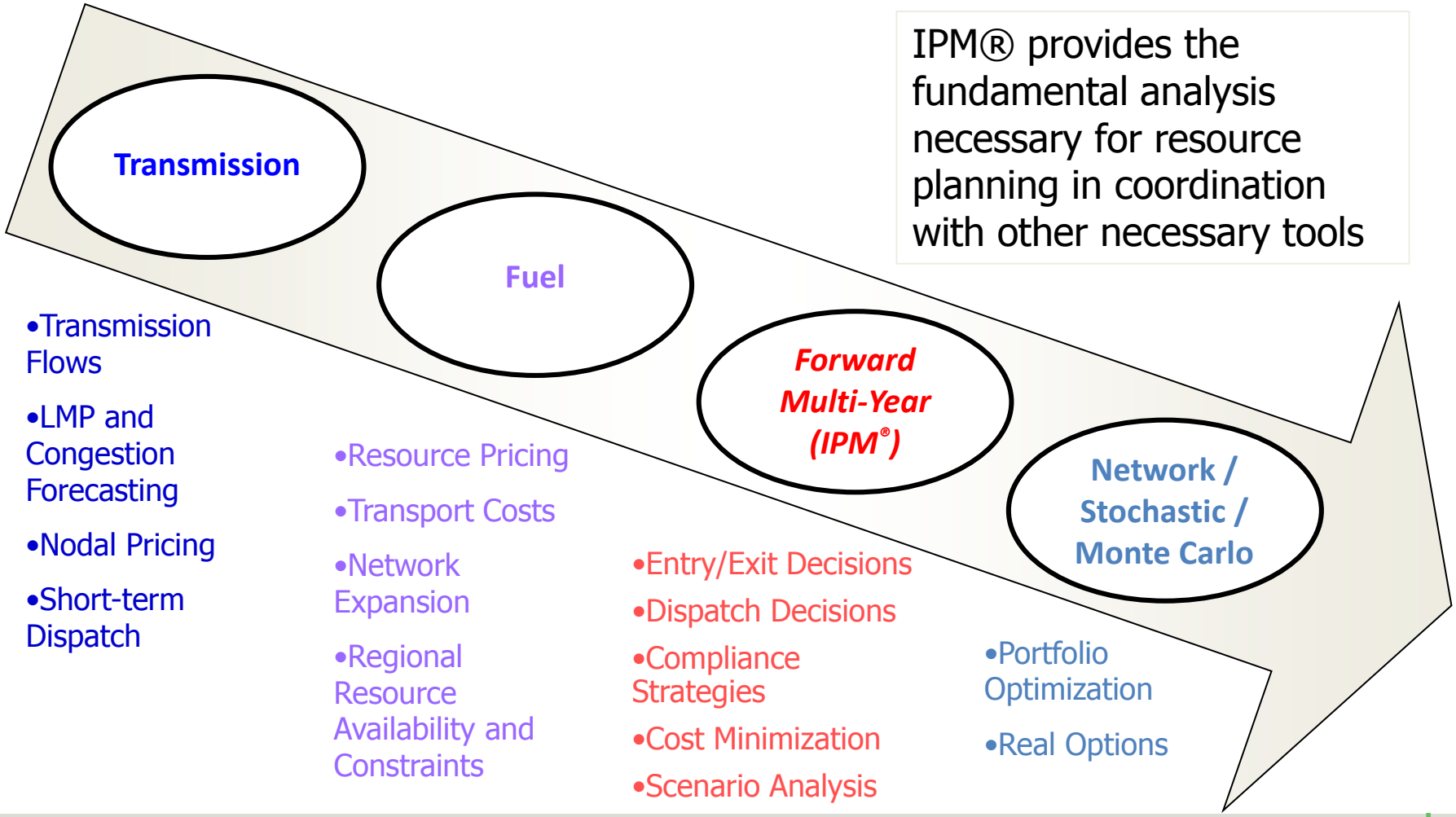
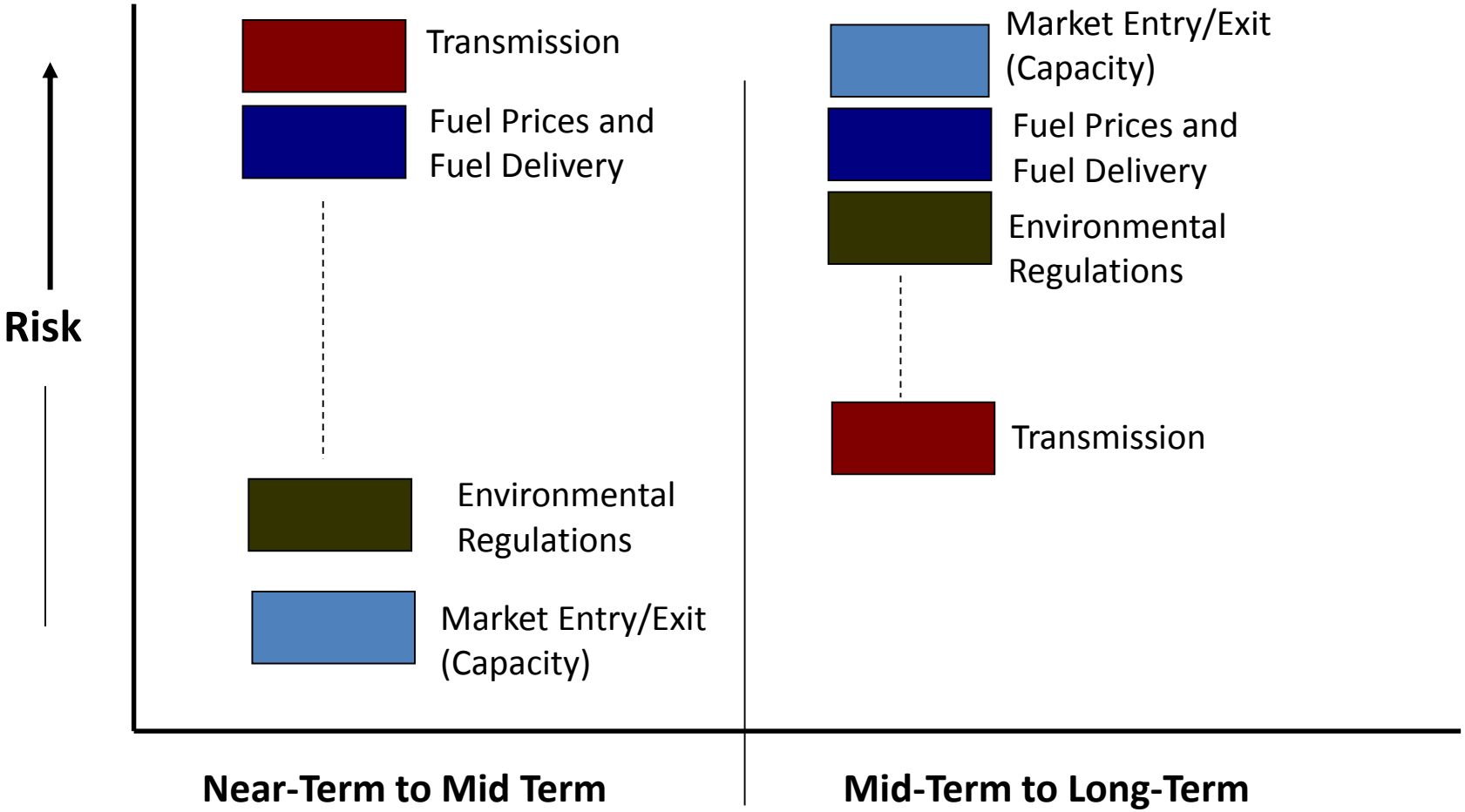
Multiple Tools allow for High-Level Review and Detailed Analysis of Issues and Risks

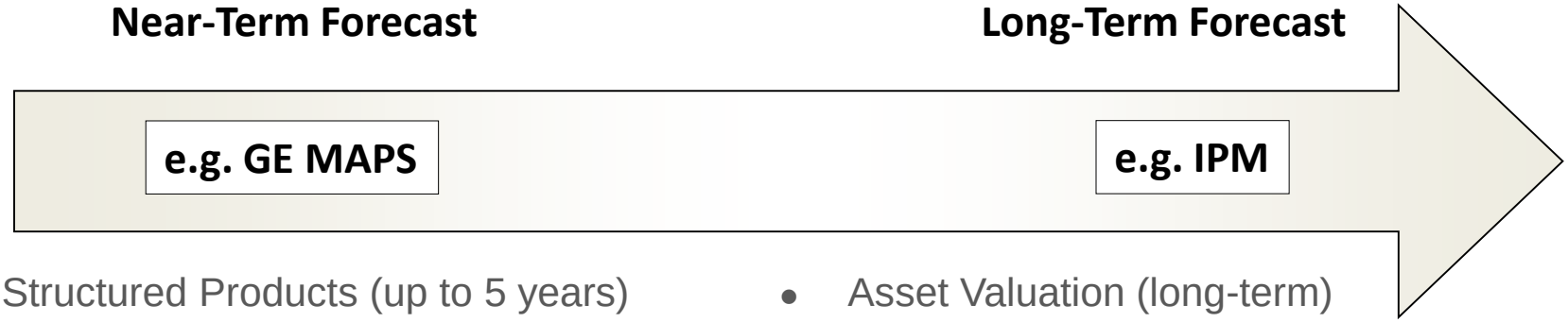


IPM® provides the fundamental analysis necessary for resource planning in coordination with other necessary tools

Pecking Order of Key Risks



ICF's Power Market Models



- Structured Products (up to 5 years)
- Energy Trading
- LMP and Congestion Forecasting
- FTR Trading, Hedging Schemes
- General Nodal Price
- Load-Weighted Zonal Price
- Line/Interface Loadings

- Asset Valuation (long-term)
- Zonal Prices
- Entry/Exit Decisions
  - New Entry – Generation and Transmission
  - Retrofit
  - Mothballing
  - Retirement
- Allowance Prices
- Environmental Compliance Strategies

Types of Power System Modeling Tools*

Reliability	Distribution Power Flow	Power Flow	Production Costing	Expansion Planning & Policy Analysis
MARS	CYMDIST	POWERWORLD	DAYZER	AURORA
REFLEX	EDGE	PSAT	GRIDVIEW	BALMOREL
SERVM	GRIDLABD	PSLF	MAPS	CAPACITY EXPANSION (ABB)
SRAM	OPEN DSS	PSSE	PCLOUDANALYTICS	EGEAS
TRELLS			PROMOD	IPM
				LEAP
				NEEM
				NEMS
				PLEXOS
				REEDS
				SDDP & OPTGEN
				UPLAN NPM
				WASP

Most applicable to IRRP

*General categorization – many tools could be placed in multiple categories

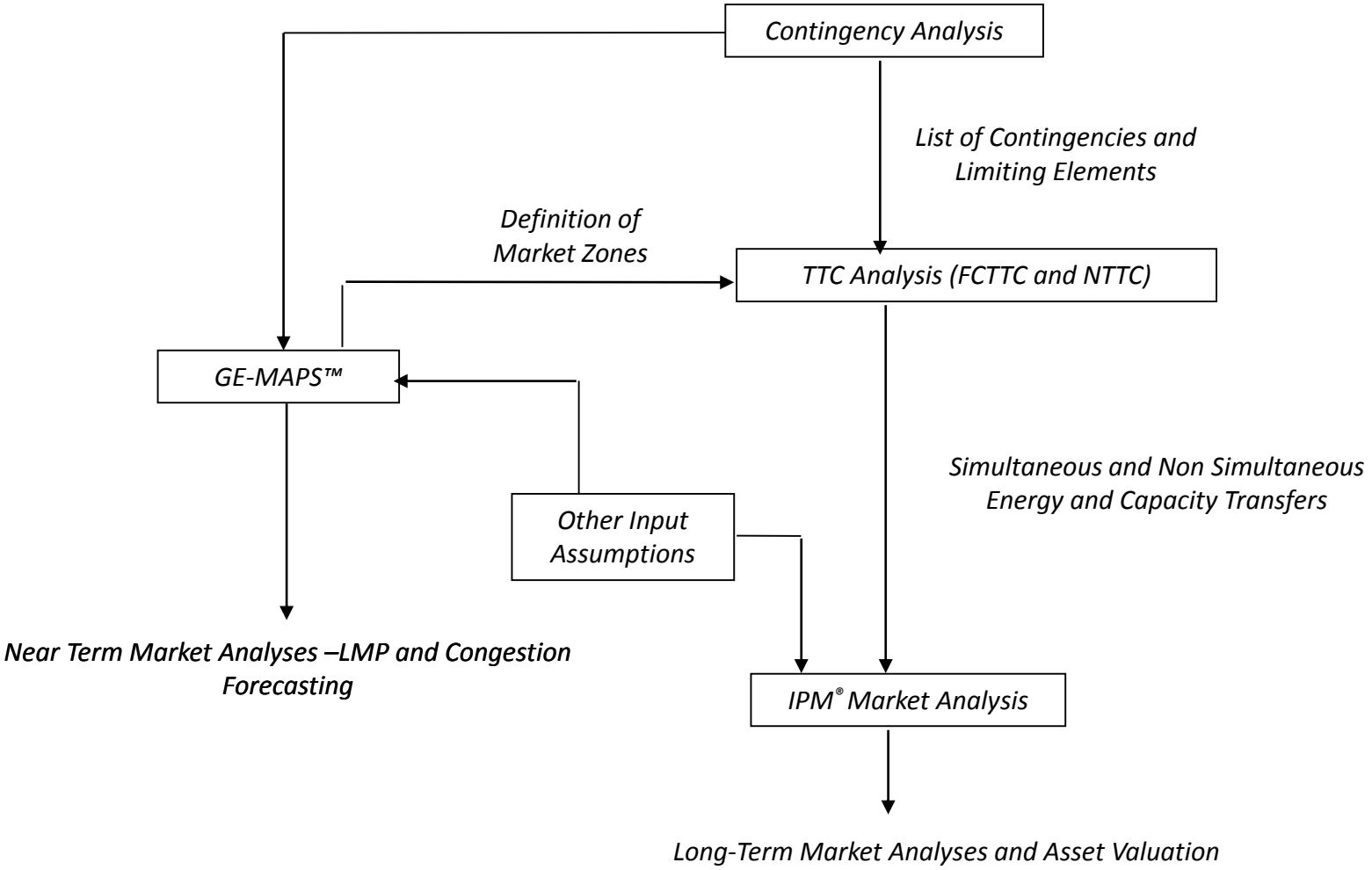
Use of Modeling Tools should be tied to Appropriate Task

Issue	First Order Analysis Tool	Second Order Analysis Tool
FTR value or hedging	Nodal Production Cost	- NA -
Environmental Compliance Decision (switch fuel, install scrubbers, etc…)	IPM (best option; rank decisions)	Production Cost (precise timing)
Build capacity	IPM (when and where)	Nodal Production Cost (identify node)
Build Transmission	IPM (when and where)	Nodal Production Cost (narrow location)
Retire or Mothball	IPM (which facilities and when)	
Invest in a project	IPM (value of investment)	MAPs (near-term dispatch constraints)

Use of Modeling Tools should be tied to Appropriate Task (continued)

Issue	First Order Analysis Tool	Second Order Analysis Tool
Cost Benefit of RTO	Production Cost	Power Flow, IPM
Environmental Impact Analysis	IPM	
Regulatory Impact Analysis	Varies	
LMP Price Projection	Production Cost (near-term)	Production Cost with IPM (long-term)
Alternate Bidding Strategies	Production Cost, IPM	
Transmission Loss Modeling	Production Cost	

Relationship of Power Market Tools



Why Consider Alternate IRRP Scopes?

- Planning exercises rely on quality data to develop outcomes.
- Goals and perspectives should be considered in framing an IRRP process.
- An IRP is a living document, reflecting the best knowledge available at the time it is prepared, and the best possible decisions in light of that information.
  - Should IRP results indicate value in renewable development, additional analysis of integration and specific resource potential may be identified
  - Should IRP results indicate high risk due to limited available fuel diversity, additional fuel supply and procurement analysis may be identified

IRP Scoping Case Study Background – Puerto Rico

- Lack of oversight and economic downturn resulted in significant financial distress for the Puerto Rico Electric Power Authority (PREPA)
- **Act 57-2014**, known as the Puerto Rico Energy Transformation and RELIEF Act
- Regulation No. 8594 of May 22, 2015, ("IRP Regulation") established the procedures for the preparation, presentation, evaluation and approval of PREPA's IRP.
- PREPA filed its first IRP on July 7, 2015. The IRP was found deficient
- Supplemental filings occurred in 2015 and 2016
- In September 2016, the PREC disapproved the IRP and approved a modified IRP which would comply with legal obligations and professional standards.
- On February 10, 2017, PREPA's motion was denied
- Statutory requirements have a July 1, 2018 filing date for PREPA's next IRP filing

Putting the Cart Before the Horse

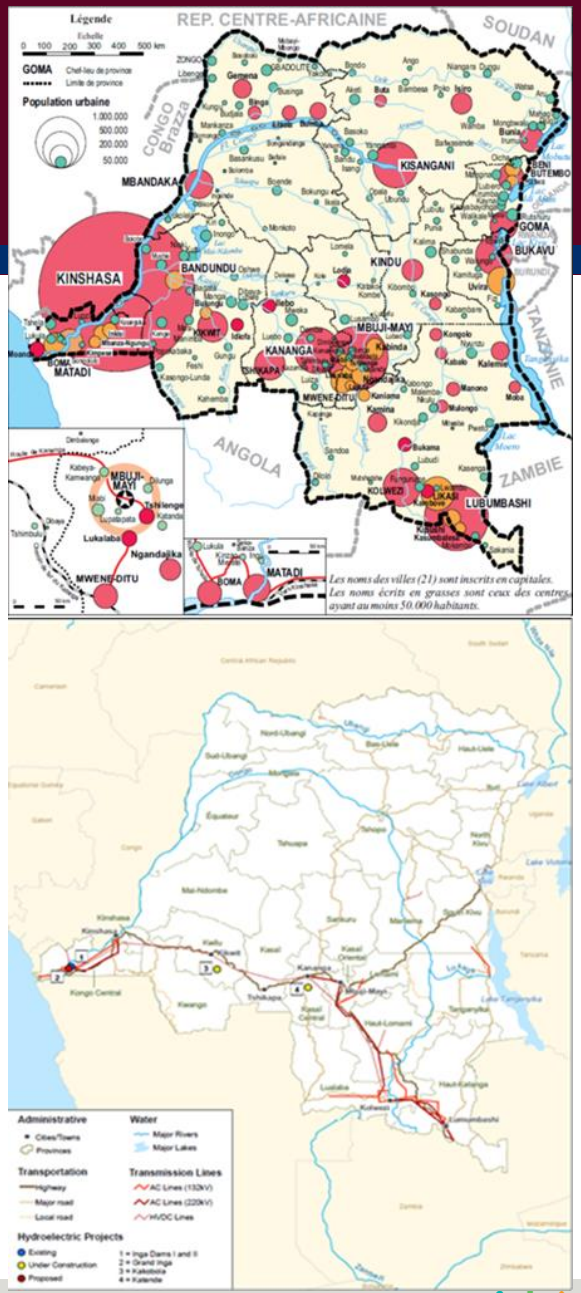
- PREPA failed to utilize a capacity expansion model, as explicitly required in Commission rules
  - PREPA relied on PROMOD, a production costing model
  - PREPA further filed analysis performed using PSSE, a detailed transmission model
  - PREPA performed a quite detailed analysis of its system, but failed to rely on higher level analytical techniques to justify the detailed modeling

- Lack of an optimization structure further meant that PREPA could not evaluate alternate resources on an equal footing
- PREPA further failed to consider alternative risk factors

Discussion Examples

Democratic Republic of the Congo (DRC)

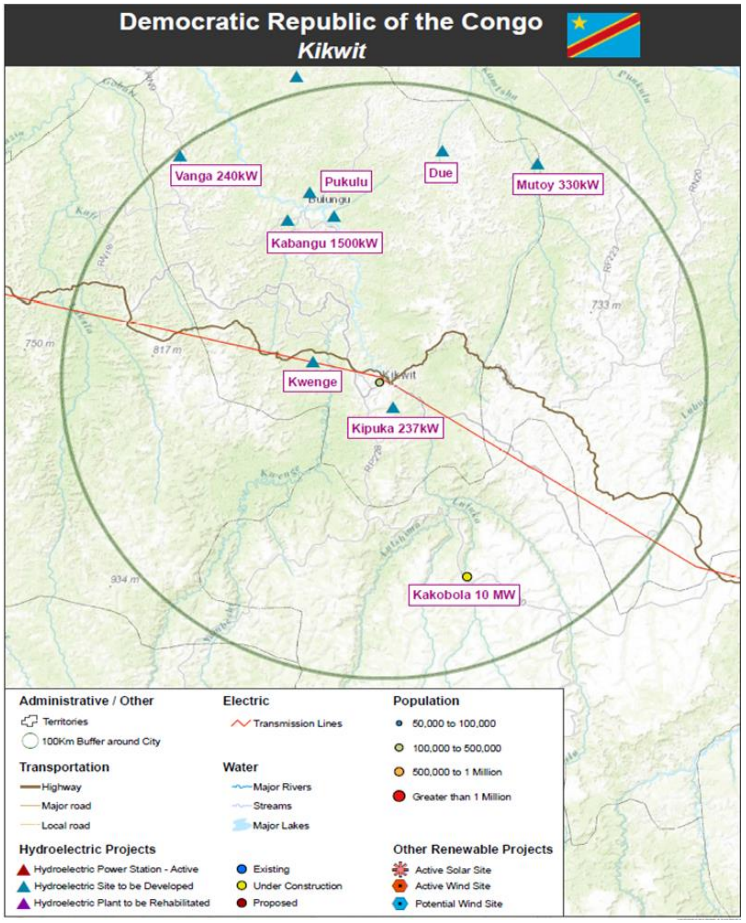
- Second largest country in Africa with a total land area of approximately 2.3 million sq.km., slightly less than one-fourth the size of the U.S.
- Population is estimated to be approximately 81.3 million as of 2016.
- Total hydropower potential is estimated at over 100,000 MW.
- Lowest electrification rates in the world, with approximately only 9% of its total population of 80 million having access to electricity.
- Electrification rate for urban areas is approximately 19%, while the rate in rural areas is 2% (as of 2013).
- Of the total installed power capacity of 2,590 MW, only half is available at any given time.
- High solar energy potential for the country (3.5 – 5.5 kWh/m2/day). No grid-connected solar, only 83 KW of off-grid solar over 836 systems.
- Majority of the country is rural in nature with inaccessible forests and unconnected villages.
- Transmission system is limited and underutilized, provides power mainly to the mines in the southeast.



Source: CIA Fact Book –See link ; World Bank – See link

IRRP Considerations - Discussion

- Demand Analysis
  - Using 250 kwh/per capita/yr, unmet demand = 4,500 MW
- Supply Sources
  - Hydropower
  - Solar
  - Diesel
- Issues:
  - Planning hydropower development
    - Large-scale vs. mini- and micro-hydro
  - Type of solar (grid vs off-grid)
  - T&D expansion
  - Off-grid localized networks (microgrids)
  - Privatization (distribution concessions)
  - Public private partnerships (BOO, BOOT etc.)
  - Decentralized control
  - Environmental and social impacts



How should the IRRP study and analysis be designed?