Introduction to Smart Grids*

*SMART GRID
Fundamentals of Design and Analysis
by James Momoh, 2012

CHAPTER 5:

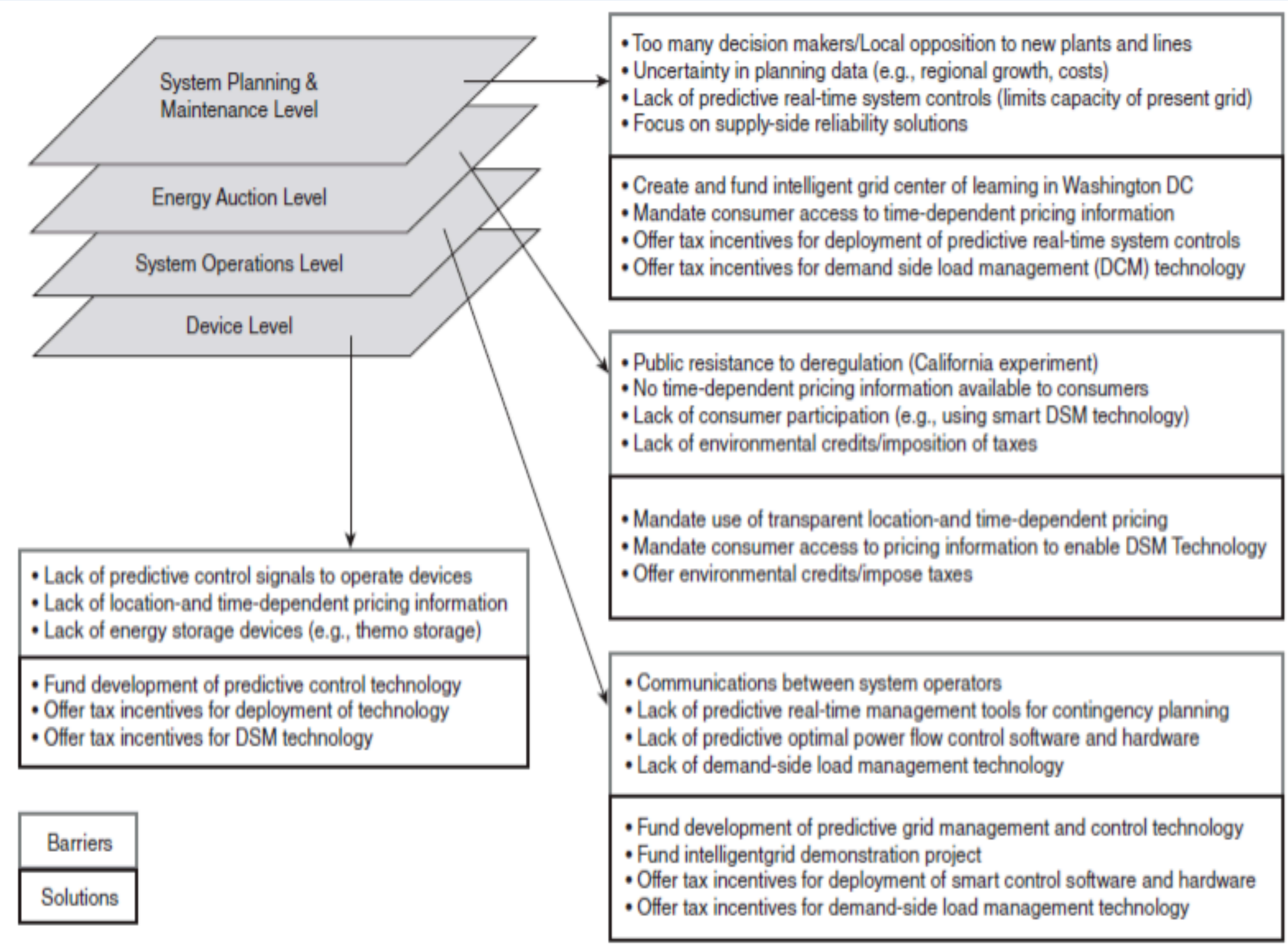
Pathway For Designing Smart Grid

OUTLINE

1. Barriers and Solutions to Smart Grid Development
2. General Level Automation
3. Bulk Power Systems Automation at Transmission Level
4. Distribution System Automation Requirement of the Power Grid
5. End User/Appliance Level of the Smart Grid
6. Applications for Adaptive Control and Optimization
7. Summary

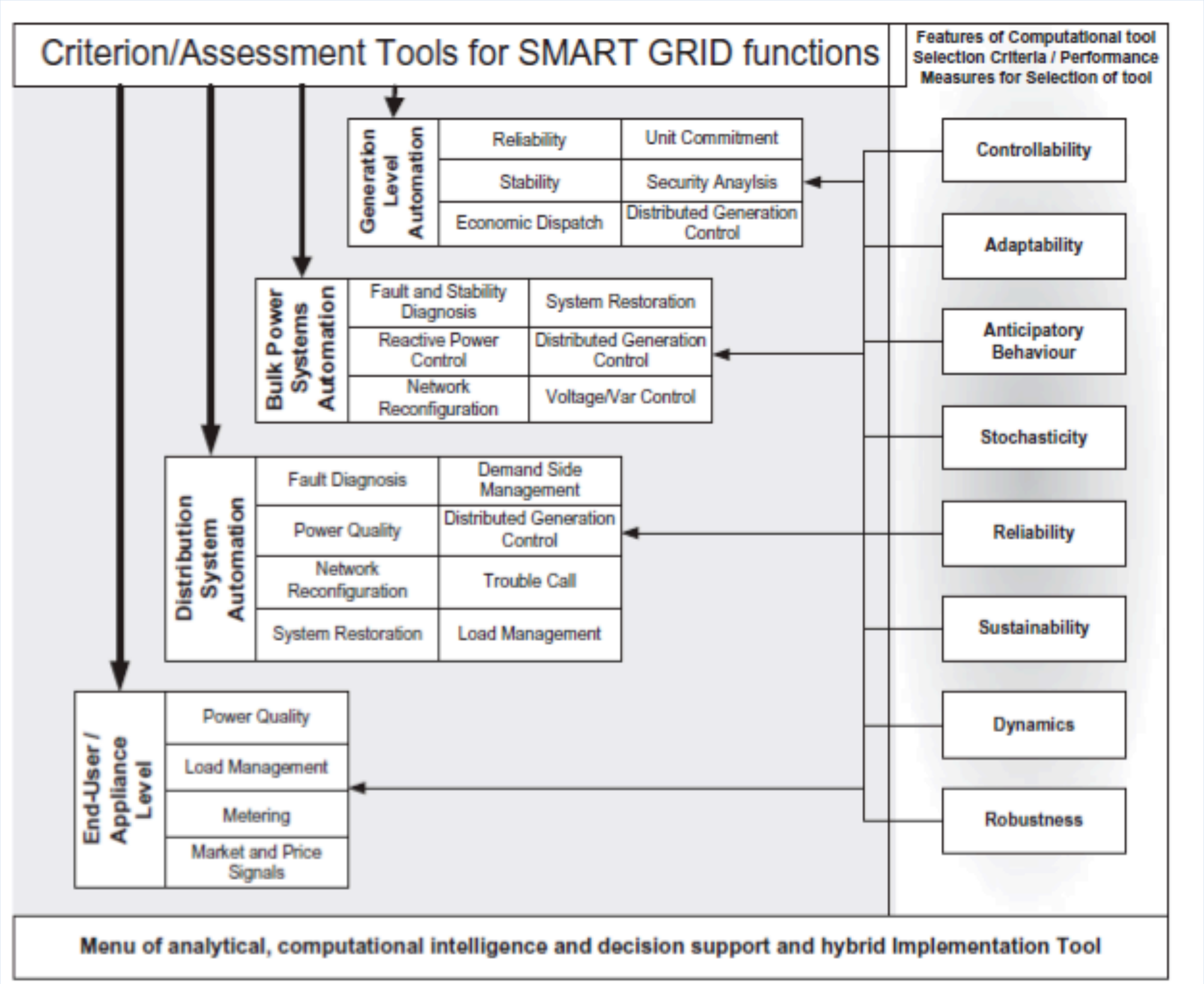
1. Barriers and Solutions to Smart Grid Development

- System Planning and Maintenance
- Energy Auction
- Systems Operations
- Device



Barriers and solutions to the smart grid.

Solution Pathways for Designing Smart Grid



Smart grid using advanced optimization and control techniques.

2. General Level Automation

- Reliability
- Stability
- Optimal dispatch
- Unit commitment under different uncertainties and constraints
- Security analysis
- Distributed generation control

Reliability

A new reliability and sustainability metric should be capable of handling:

- Nonlinearity of the system parameters, especially in the presence of the new mix of generation resources
- Uncertainty in load demand and generation
- System dynamics that refl ect the market, availability of natural resources, network reconfiguration, and load switching
- Stochasticity of the system parameters due to man - made or natural events

Stability

At the generation level, transient stability is the primary consideration.

Since the margin of stability cannot be obtained using numerical methods, an energy - based method has been utilized for angle stability.

WAMS and PMU measurements prepared for the smart gird environment will

allow for the real - time evaluation of the system under different loading and unknown contingencies.

Economic Dispatch

A computational process where the total required generation including renewable energy resources is distributed among the generation units in operation by minimizing the selected cost criterion subject to load and operational constraints.

Unit Commitment

UC scheduling covers the scope of hourly power system operation decisions with a one - day to one - week horizon.

The UC schedule is obtained by considering:

- Unit operating constraints and costs
- Generation and reserve constraints
- Plant startup constraints
- Network constraints

Security Analysis

Whether the power system is in a secure state or an alert state.

Secure state implies that the load is satisfied and no limit violations will occur under the current operating conditions and in the presence of unforeseen contingencies.

Alert state implies that particular limits are violated and/or the load demand cannot be met, and corrective actions are necessary to bring the system back to the secure state .

3. Bulk Power Systems Automation of the SG at Transmission Level

The following functions are evaluated, and the appropriate intelligent technology is proposed:

- Real - time angle, voltage stability, and collapse detection and prevention via intelligent - based data
- Reactive power control based on intelligent coordination controls
- Fault analysis and reconfi guration schemes based on intelligent switching operations
- Power generation and load balance via intelligent switching operation and minimizing demand interruption
- DG and DSM via DR strategy for peak shaving, including increased proliferation and control of RER

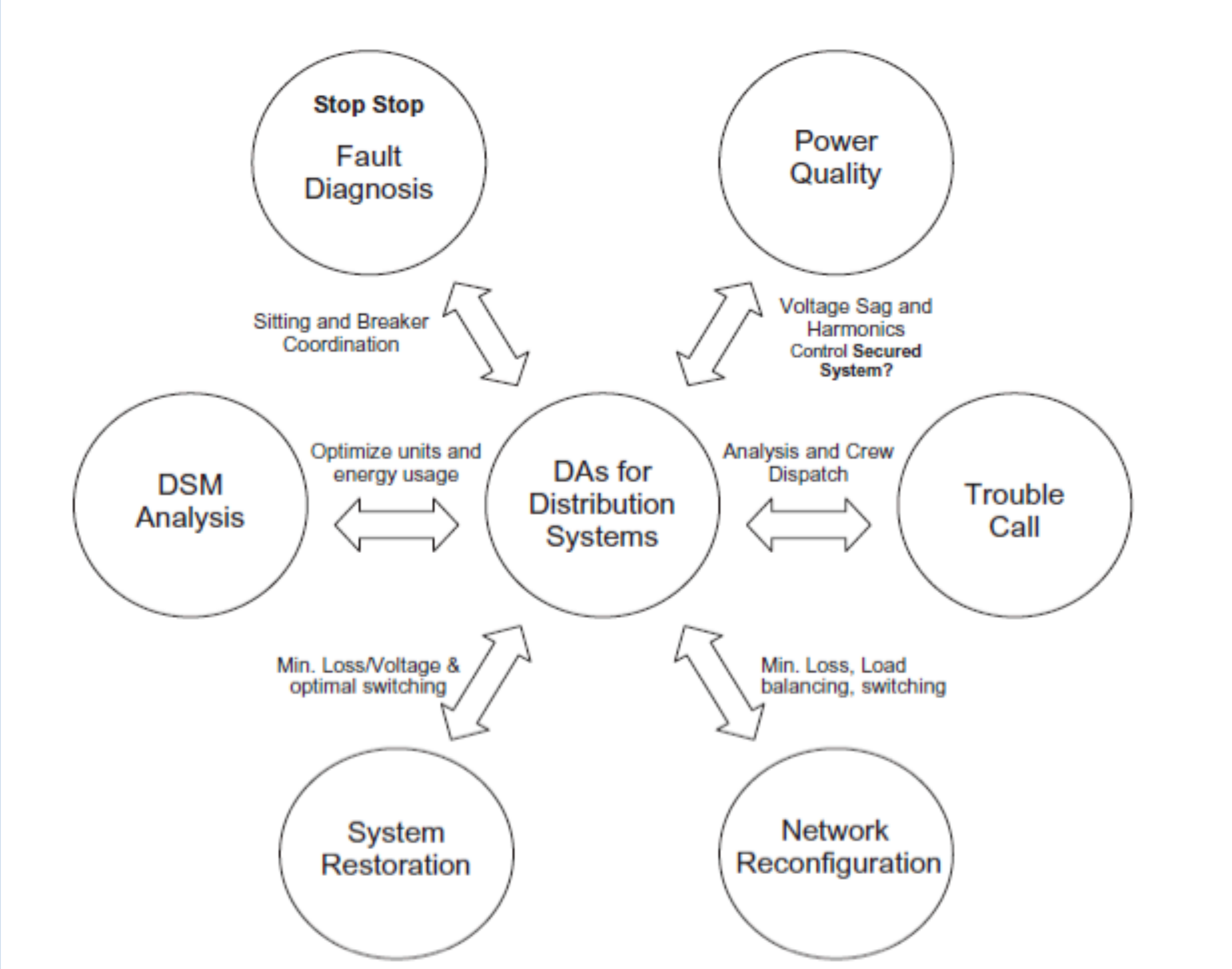
3. Bulk Power Systems Automation of the SG at Transmission Level

- Fault and Stability Diagnosis
- Reactive Power Control

4. Distribution System Automation Requirement

1. Voltage/Var Control
2. Power Quality
3. Network Configuration
4. Demand – Side Management
5. Distribution Generation Control

4. Distribution System Automation Requirement



Distribution automation for distribution systems.

5. End User/Appliance Level of the SG

Significant changes in metering and monitoring DSM (Demand Side Management) and DR (Demand Response)

Unit commitment	**Optimal power flow**
Load reduction forecasting	Survey methods
Engineering features of the end-user equipment interruptible load management program	

6. Applications for Adaptive Control and Optimization

In DSOPF, the efficient optimization technique typically based on two - stage action
and critic networks are used to achieve:

- Multiobjective, time - dependent optimization for complex systems
- Optimal scheduling subject to technical constraints of the plant or system
- Adaptation to perturbation of power system dynamics over time
- Adaptation to varying random noise, uncertainties, and/or missing or corrupted
measurements
- Adaptation to changes in system structure while distinguishing between observable
and unobservable measurements