3.2.1

ENHANCING RELIABILITY, RESILIENCY, SUSTAINABILITY AND AFFORDABILITY THROUGH NEW CUSTOMER CENTRIC WHOLESALE AND RETAIL ELECTRICITY MARKET DESIGNS AND POLICIES

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2.1. INTRODUCTION

About two thirds of the Electric Industry in the US is based on an organized market through wholesale market. Here all utility distribution companies get their support from a main source and depends on generation companies which also dependent on transmission networks owned or controlled by the national government. From the whole seller the Regional Transmission Operator (RTO) or Independent System Operator (ISO) dispatches the power from bulk grid power to distribution companies to reach customer. The development of this system was a great intellectual achievement, due to breakthrough crossdisciplinary research combining microeconomics, power engineering and advanced algorithms developed largely through the IEEE Power and Energy Society, initially funded by a small but focused partnership of the National Science Foundation and the Electric Power Research Institute (EPRI).

However, this great advance was only a first step towards true, more optimal market design and technology. The wholesale electricity market design lacks adequate policy and rules for emerging technologies such as Renewable Energy Resources, Hydrogen and Nuclear energy Sources, Storage Technologies, and others. Furthermore, their dispatch mandate is based on traditional economic dispatch methods to schedule the most economic units.

The present system works well when disturbances and surprises are limited, and when it works well enough to plan ahead only a few steps into the future. However, new renewable sources, like the large solar thermal farms emphasized in this book, share a basic problem we also face with older renewable energy sources, when used in today's power grids. They simply cannot compete with fossil fuels in most large markets today, because they require efficient use of new storage options and power conditioning, and backups. These in turn would multiply the cost to the consumer many times over, in the real world, as the EU has learned in its recent evaluations of ways to cut back on fossil fuel. To solve these problems, we need major changes in the grid itself, to take full advantage of exciting new proven storage option like the thermal storage now led by Chile, far cheaper than batteries and less wasteful than pumped hydro. These new technologies, and the new market designs which take full advantage of them, are the most urgent need all across climate policies aimed at maximum affordable and timely results.

This can be seen in markets such as Pennsylvania, New Jersey, and Maryland (PJM), with RTO that has 13 states under it, California Independent System Operator (CAISO) which control the west coast utilities, Midwest ISO, New England ISO, and others all manage their wholesale mandate within the neighboring states. Each of these state-owned utilities are not allowed to operate without the oversight of FERC regulation which does not allow them to dispatch units such as RER, Nuclear and other units. The inter-state challenge in the grid transmission or distribution that cross their states includes conflicting regulation or policy to allow RER and Nuclear resources.

2.2. A RECENT JOINT ACTIVITY AT FEDERAL AND STATE LEVEL TO IMPROVE ELECTRICITY MARKET

The Federal regulation until recently does not have transmission or distribution policy that is innovative for clean energy or externalities that support decarbonization. The different roles of States and Federal has led to conflict in the current market design.

Some of the state requirements include:

- State want to have a goal of allowing dispatchable units, renewable energy, and nuclear resources, which will contribute to local load power supply at affordable price and also meet Environmental Social Goals (ESG) for both customer, industry and transportation system that will run with clean and efficient supply.

However, given the recent shut down of nuclear power production, States such as Chicago (Exelon) have pushed against Federal Laws so that RER and Virtual Power Plants (VPP) that can help to contribute to job creation, funding for schools and other social/developmental programs. If allowed, this means we will have renewable energy and nuclear energy at an affordable cost and that will be manageable without State subsidy while Federal provides subsidy for RER in the market design through tax credit for RER usage at a reduced cost.

A joint State and Federal task force is set up to improve transmission development. The task force involves FERC Commissioners to work on ten state regulators to achieve the following:

- Identify barriers that inhibit Optional transmission planning and development
- Explore potential basis for states to use FERC transmission planning process
- Explore states voluntary coordination on transmission planning and development
- Review FERC rules and regulations regarding planning and cost allocation for reforms
- Examine barriers to interconnection
- Discuss mechanisms to ensure that transmission investment is cost effective.

Vertically integrated system separate their energy supply and transmission functions to avoid political control of self-holding which leads to ceding the operational control of their transmission function as a third party. This has led to a FERC Order on Open Transmission Access that has been extended to coordinated market by using OATTT (Open Access Transmission Service). This approach has led to minimum attention to care for the so-called standard market design. Hence, the need for alternate management of bilateral contracts with self-generated electricity model.

A new FERC order 2222 has emerged to allow renewables, energy storage, and distributed energy resources to be aggregated to participate in bulk power markets on the same basis as utility power supply chain. The issues to be considered is if VPP such as nuclear and renewable resources are to bid in the wholesale electricity market and be treated as actual power plants, even though they are not operational and flexible. And considering to what extent storage technologies is used as a backup for extreme events or when resources are scarce. This issue will satisfy requirements for day ahead market schedules of RTO and to provide capacity or energy requirements.

2.3. NEW GRID PLANNING TO ACCOMMODATE DECARBONIZATION AND NEW MARKET

A decarbonization goal to harmonize market supplies by both the States and Federal regulations. The traditional power technology that goes from generation to load (customer) has to change to have renewable energy and allow bidirectional flow of power. In the present state, the technology must allow new prosumer (someone who can buy and sell) to transfer power to the grid in a bidirectional power flow. This operation requires smart inverters and automation and ability to provide load following, frequency control, voltage control in a digitized setting. For example, the old controllers such as transformers are not prepared to handle bidirectional power flow, the absence of smart inverters, lack of distribution automation, frequency control and voltage control for future grid. The current architecture needs to handle the emerging technologies and objectives to achieve the following multi objectives: Reliability, Resiliency, Sustainability and Affordability.

These goals can be achieved if we have a national grid that allows for interstate transaction of energy sources while satisfying the multi state road and land right -of -way requirements at the state boundary. This grid pathways must allow for integration of RER and nuclear resources to participate in the Retail /Wholesale market to achieve national goal which is defined by national policy.

The national goal is to develop a grid that provides access for RER market in the USA, create smart grid attributes for communities to sell power and reduce decarbonization. The access to this goal is by providing or moving to Transactional Electricity Market (TCM). TCM is defined as a case where utility no longer dominate the market and other players are involved in the new market to enhance Reliability, Resiliency, Sustainability and Affordability (2RS+A).

This objective will allow electric supply chain to meet clean energy attribute’s goal. This leads to a design of a new framework for achieving the 2RS+A for customer centric market. The outcome is good for public policy for any government both locally and internationally.

2.3.1. New Power Grid Architectural Design

As discussed before, the network architecture as to be redesigned with the understanding that different evolving electricity sources such as small size nuclear plant and RERs will be obtained. We here by recommend a national grid that can accommodate RER (wind, solar pv), storage technologies, nuclear power and use gas as a bridge.

The base load fossil plant can no longer support uncertainty in load rather support has to be provided by designing storage. The energy from such storage resources such as battery and other storage technologies is required for reliability. Furthermore, the current energy mix will account for uncertainties due to weather or extreme events. A dynamic market based on robust optimization is required to provide a market that meet 2RS+A.

2.4. FUNDAMENTAL ISSUES OF MARKET DESIGN

Current use of market model using Locational Marginal Price (LMP) or zonal based pricing is not supported by right architecture of the grid, sound policy, and right regulation. In addition, it does not capture decarbonization or other externalities. Hence, we propose to advance the market design by looking at elements for emerging technologies and innovative policy and regulation to meet the goal for achieving Reliability, Resiliency, Sustainability and Affordability with Customer Centric Through a New Wholesale and Retail Electricity Market Design. Following the power restructuring with unbundle power markets there is no single market structure in the US. We have long term contract and short term daily or hourly sales contract as part of the production. The whole sale market is managed by RTO/ISO based on market rules by FERC orders. In some part of the country, it is handled by loading through diversification of generation assets. We define here the new strategy to enhance Wholesale or retail market.

Reliability: is defined for meeting minimum requirements of down time of failure, reducing loss of load probability and greater quality of service to customer by the grid management or provide ISO and RTO at both state and federal level for bulk wholesale and retail market. The current indices of System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) will not be enough, hence other indices such as Loss of Load Probability (LOLP) and Customer Average Interruption Frequency Index (CAIFI) need to be added.

Resiliency: is the ability of the grid to recover to its normal state following a catastrophic or abnormal contingencies of fault or events and withstand sudden disturbances. The design of such systems are based on design of system with multiple alternate functions such as microgrid which provides ancillary services to reconstruct the possible breakdown of the grid.

Sustainability: is the ability to provide future grid to handle decarbonization requirements by allowing virtual resources such as RER, Nuclear, Storage. The technology to achieve this system of systems is to introduce RERs and Nuclear plant in the grid supply chain and it can be sited within the microgrid at the load end, or close to source instead of fossil fuel injection with necessary electronic devices for full coupling, penetration, and integration. Sustainability increase efforts for Clean Energy applications.

Affordability: The traditional portfolio in the grid which integrate RERs and energy efficiency technologies, demand side response and new pricing mechanism with customer centric allows for optimal costing.

2.5. NEW MARKET DESIGN

It is noted that the role of power supply is changing due to changing roles of power plant, utility and customer. However, it is fair to state that the one unchanging goal is decarbonization which must meet multiple objective function for organized market to include retail to non-retail market but must meet the 2RS+A. The first two are very important factor which drives the public to make decision on whose power they will buy and how much they are willing to pay under the rubric of ESG. The ESG goal is expected by industry and commercial customers who are looking for smart lighting, provide quality power, meet heating and cooling requirements and provide it with clean energy at affordable price.

Market designs should, in addition to integrate variable renewable energy, be inclusive of emerging technologies, such as demand response, distributed generation, and distributed storage. This is argued by the fact that these technologies have the potential to reduce system costs. It should be considered, however, that additions to the current market design affect directly or indirectly the decisions made by market parties on their new generation investments and also on whether or not they should retire existing assets.

2.5.1. Market Participants – Who are They?

To achieve this objective the different players, have to collaborate together. The different market participants for both the wholesale and retail markets are as follows:

- Utilities: Who are responsible to distribute power from wholesale markets
- Independent Power Producers (IPP)
- Large Industrial customers who are building high voltage plants
- Digital companies such as Google
- Regulators
- ISO and RTOs

The participant must provide oversight to define electricity market and agree on who designs the market, who regulates the market and their roles. These participants must all define the goals and sit in the table with customers to ensure acceptable pricing and corresponding 2RS+A and appropriate pricing model.

2.6.PRICE SIGNAL FOR SEGMENTATION OF CUSTOMER

The traditional cost-load based on Rate-Based Reliability (RBR) will no longer works because the drivers such as grid transformation, changing energy sources, integrating clean energy, customer aggregation, demand response, increasing severe weather events and hardening the grid has not taken account of electricity with respect to reliability of service. There is a need for action for customer to pay for reliability of what they received. The service provider must supply or invest on the quality of service.

The traditional residential, commercial and industry tariffs will not work. We need to segment prices according to customer based on choices of electricity, quality, or reliability provided. For instance, customer should be charged based on reliability of power received. The case of disadvantage people paying for the rich for reliable supply especially when the Federal Government subsidize for electricity supply chain no longer tolerable.

In The US NERC and FERC control and manage transmission networks performance and standards. Tariff issues are addressed by the regulators through an approved rate charges and advise on the fair price based on standard that has been properly negotiated by all parties involved and ensure it is lawful and fair. With incentive given to market players and ensure reliable and service to customers, this is a win-win market for all.

2.6.1. Handling Segmentation of Prices in Electricity Market

The concept of dividing customer into segments should be based on hours of services received and should commensurate with the cost of power received during the day which calls for regulatory and new policy direction.

A case in Africa (Nigeria) is already in place where customers are divided into the following bands:

- Band A: Customer in this band receive power between 20-24 Hrs a day and they pay more.
- Band B: Customer in band receive power between 16-20 Hrs a day and they receive power more than band C.
- Band C: Customer receive power for 12-16 Hrs and receive more power than band D.
- Band D: Customer who receive power between 8-12 Hrs.
- Band E: Receive power less than 8 Hrs and pay less than all the other bands.

A case for USA, a new Price Signal methods will be developed by following the steps:

1. Review the current method of price signal used in the state or federal level in the US or other countries in Europe and Asia.
2. Identify gaps and problems with and without proper segmentation.
3. Compare the segmentation methods with traditional methods which we now will not work in the new market with the goal of 2RS+A for decarbonization goal.
4. Develop Price Signal that determines price sensitivity to reliable and sustainable power which leads to decarbonization.
5. Compare or utilize the framework obtained from other countries and increase the implementation for meeting the decarbonization goal.
6. Utilize pricing that includes variability of what the customer gets to achieve reliability. i.e., $Price = Fixed\ Price + \alpha\omega$

Where, $\alpha\omega$ is a measure of cost employed to achieve reliability by paying for improvements in the design by introducing new technology, storage systems, automation, power quality improvements, voltage control, frequency control, etc.

2.7. STORAGE TECHNOLOGIES

Technologies contributing to improve pricing of new market design with decarbonization policy is given the role of RER, Hydrogen and Nuclear sources across the state boundary and appropriate wholesale or non-wholesale will provide the need for storage options.

Battery used for 12 Hrs is not sufficient, hence an advanced battery technology that can last for 2 days or more is required or other advanced storage technologies to be able to store energy from PV or Wind systems.

List of Available Storage Options are shown in Table 2.1.

Table 2.1: List of Storage Technologies

Technologies	**Properties**
Solid state batteries	• Nano composite electrolyte • Compact with thin-film stack
Thermal storage	• Next generation non-intermittent and cost-competitive solar thermal power plant • Thermal energy from sun stored in the form of chemical bonds
Flywheel	• High energy density and reliability • Rotational speeds higher than 100,000 RPM.
Pumper hydro storage	• Two water reservoirs at different elevations to pump water from the lower to the upper reservoir (charging) • Efficiency ranges from 60% to 75% • Long lifetime and practically unlimited cycle stability
Compressed Air energy storage	• Air is compressed using electricity. • Compressed air is mixed with natural gas, burned and expanded in a modified gas turbine.

The Area of Energy Storage system (ESS) in the new market will be discussed as the integrated 2RS+A framework is developed.

2.8. ATTRIBUTES OF MICROGRID AS ANCILLARY SERVICE

Because of the need for automation and backup power supply renewable energy based microgrid is necessary.

A microgrid system is proposed and desirable here in with the following attributes and architecture as shown in Figure 2.1. Microgrids has emerged as an alternative to address a rising demand of sustainable energy production with quality and reliable electric infrastructure. With integration of advanced control and automation technologies microgrids have much more potential than being back up or peak hour supplies for residential supplies. The integrated renewable and conventional power generating units adds technical, economic, and environmental incentives to the power system networks. Advancements in microgrid and smart grid application provides a win-win situation where utility companies, service providers and consumers work together for increased reliability, efficiency, and sustainability.

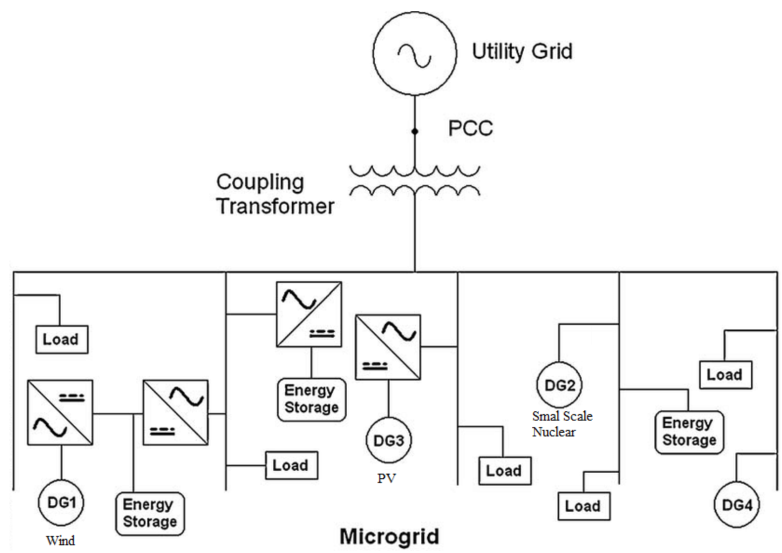

Figure 2.1: Microgrid Architecture with Mixed Energy Sources

Microgrids have been around for a while, mainly in remote rural areas throughout the world. The novelty is the advent of smart microgrids provided with the following

- power electronic devices with fast control capabilities.
- DC networks with controlled voltage levels.
- Fast solid-sate breakers with remote control capabilities via transmitters and receivers.
- broadband communications and the Internet.

- generation units such as microturbines, fuel cells, photovoltaic panels, wind turbines.
- storage devices such as flywheels, batteries, air compressors, to name a few.

2.8.1. Ancillary Technologies

In the new grid, microgrid Systems provides ancillary services and help to improve reliability, stability and resiliency of the network which normally are functions that are paid for. To finally meet the challenges of the bulk grid system, ancillary services provides of provide the following:

- Voltage/ Var control which contributes to system reliability
- Startup – contribute to sustainability
- Stability problem - contributes to resilience
- Load frequency control - contributes to resilience

Ancillary services plays a major role in maintaining the proper power flow to address power imbalances between supply and demand and help system recover from extreme events. In the presence of renewable resources Ancillary services help to manage the variability and uncertainty issues in the network. Overall, Ancillary services helps to achieve 2RS+A.

2.8.2. Distribution Automation in the Future Market Design

The evolution of communication and information technology has motivated the idea of Distribution Automation (DA). The principal objective of DA ae energy conservation through reduction of losses, peak load and energy consumption. Major areas covered by distribution automation are:

- Demand Side Management
- Voltage Regulation/Var control
- Real time Pricing
- Dispersed Generation and Storage Dispatch
- Fault Diagnosis/Location
- Power Quality
- Reconfiguration
- Restoration
- Visualization

Distribution automation is a critical component for the development of the smart grid features for the distribution module. Artificial Intelligence (AI) base techniques plays a major role in solving such functions.

2.9. REFORMING THE MARKET

The main work in reforming the market is identifying the action weather it is a public policy issue, it is a regulatory act or technology design through a network redesign.

The response is an inclusive of so many factors previously discussed in this chapter, we reformulate and recast here in:

I. First, we need to address the new market design by an optimization process that go beyond classical economic dispatch called Security Constrained Optimal Power Flow (SCOPF).

   The classical economic dispatch have the following demerits:

   - It does not account for the decarbonization
   - It does not have storage capacity
   - It does not provide RER and small size nuclear plant.

II. Provisions or rules and regulation must come in to include segments of customer types of service and price grading based on price signals in terms of band A, B, C, D and E as in the case of Nigeria.

A sustainable electricity supply industry based on renewables requires a cost-effective match between renewable generation and demand, Current market design does not offer sufficient incentives for investing in dispatch able generation. By strengthening energy-only markets, participants have individual responsibility to meet their supply and purchase commitments. With the enhancement of RES, annual renewable penetration targets and a cost-effective power generation should be ensured. In case the effectiveness of energy-only markets is doubted, additional regulatory interventions are acceptable.

The Fundamental goal of the Sustainable Market Design (SMD) requirements, in a conjunction with the standard transmission services, is to create seamless wholesale power markets that allow sellers to transact nearly across transmission grid boundaries that allow customers to receive the benefit of power cost and more reliable electricity supply.

2.10. DESIGN OF OPTIMIZATION METHODS FOR THE NEW SUSTAINABLE MARKET DESIGN (SMD)

The formulation of SCCOPF to be used by despatchers, ISO/RTO, are defined by the following features:

- It includes dispatch of RER, Nuclear, Hydro, or other clean energy resources.
- It include between of small size nuclear plants to provide affordability index
- Incorporate 2RS+A in the formulation
- Include concept of fixed and variable cost to the RERs and nuclear plants
- Provide model or measures of decarbonization based on RERs and small size nuclear plants
- Define attribute and usage of microgrid in the network to provide voltage var, frequency control, load following or power quality or stability in static and dynamic condition. All these become a very standard dynamic optimization.

The general formulation of the classical Security Constrained Optimal Power Flow (SCOPF) is shown in Eq. (2.1) – (2.4) below.

$$\min \quad f(x^0, u^0) \tag{2.1}$$

s.t.

$$x^k(x^k, u^k) = 0 \tag{2.2}$$

$$h^{k,min} \leq x^k \leq h^{k,max} = 0 \tag{2.3}$$

$$|u^k, u^0| \leq u^{k,max} \tag{2.4}$$

k=0,1.c

where, f is the objective function usually a cost function, x^k is a vector of state variables (real and imaginary voltage at each bus), u^k is vector of control variables (active and reactive power, shunt element reactance and load apparent power) at base case

The above formulation does not account for the features that are required by the new electric market design. Hence, it has to be replaced by the new Security Constrained Clean Optimal Power Flow that incorporate the 2RS+A requirement in the formulation.

Objective function

Maximizing the reliability, Resiliency, Sustainability and Affordability functions (2RS+A) when subjected to equality and inequality constraints.

$$F = F_{Reliability} + F_{Resiliency} + F_{Sustainability} + F_{Affrodability} \quad (2.5)$$

Constraints

The constraints to consider include power balance, generator capacity, spinning reserve constraint for critical load, storage technology state of charge constraint and charging and discharging rates.

$$\sum_{i=1}^{Nbus} P_{Gi} + P_{wi} + P_{si} = \sum_{i=1}^{Nbus} P_{di} + P_{Loss} \quad (2.6)$$

$$\sum_{i=1}^{Nbus} Q_{Gi} + Q_{wi} + Q_{si} = \sum_{i=1}^{Nbus} Q_{di} + Q_{Loss} \quad (2.7)$$

$$v_i^{min} \leq v_i \leq v_i^{max} \quad (2.8)$$

$$P_{Gi}^{min} \leq P_{Gi} \leq P_{Gi}^{max} \quad (2.9)$$

$$Q_{Gi}^{min} \leq Q_{Gi} \leq Q_{Gi}^{max} \quad (2.10)$$

$$P_{wi}^{min} \leq P_{wi} \leq P_{wi}^{max} \quad (2.11)$$

$$Q_{wi}^{min} \leq Q_{wi} \leq Q_{wi}^{max} \quad (2.12)$$

$$P_{si}^{min} \leq P_{si} \leq P_{si}^{max} \quad (2.13)$$

$$Q_{si}^{min} \leq Q_{si} \leq Q_{si}^{max} \quad (2.14)$$

$$SOC^{min} \leq SOC_n \leq SOC^{max} \quad (2.15)$$

Where, P_{wi} and P_{si} are power from renewable energies such as wind and solar and P_{Gi} is power from generating units such as small-scale nuclear plants.

Various optimal decision-making methods are summarized in Figure 2.2 below. The details of each method are summarized in Momoh()

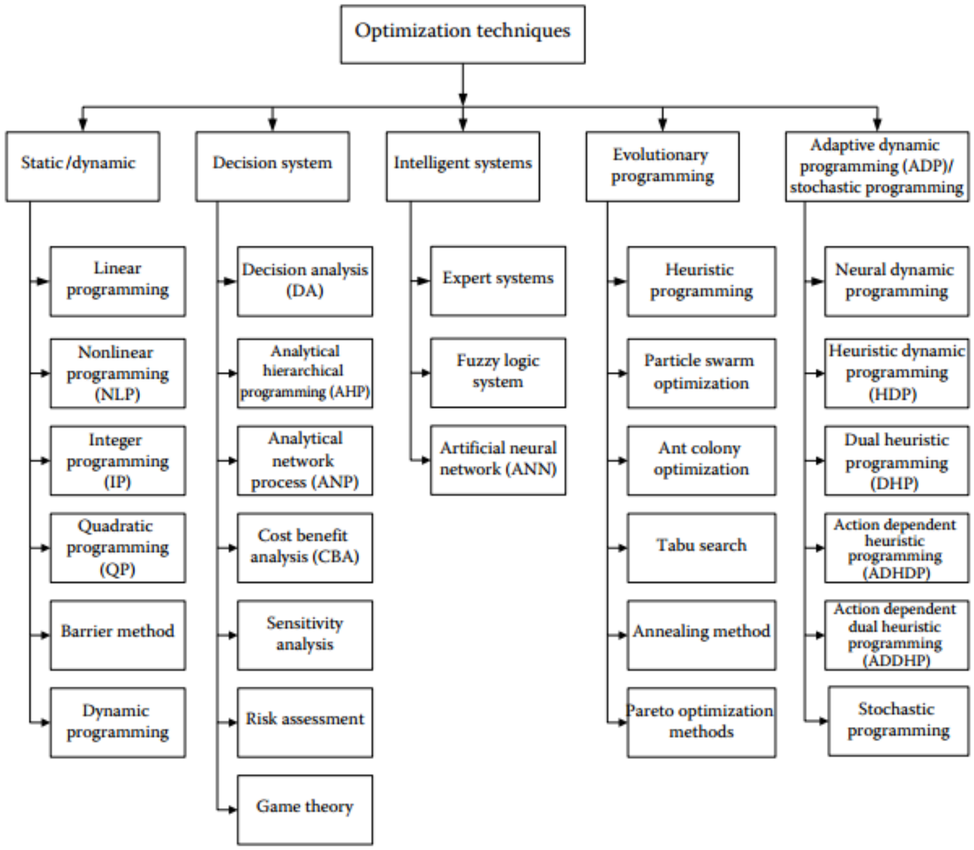

Figure 2.2: Various Classical and Advanced Optimization Techniques

Despite the tools discussed in Figure 2.2, the problem at hand has limitation and may requires the use of hybrid of these methods to account for different static and stochastic models and. Decision support scheme to handle auxiliary optimization such as policy and regulatory constraints

2.11. EXTENDING FROM ROBUST INTERIOR POINT OPF (RIOPF) DYNAMIC STOCHASTIC OPTIMAL POWER FLOW (DSOPF)

Previous works on robust DSOPF development by James Momoh by of EPRI project Robust Interior Point OPF (RIOPF) which provides opportunity for multiple objective functions that can handle static OPF using a fast interior point optimization method.

The work has been extended to include capability to handle RER and discrete resources. A follow up work is currently going on to include stochastic of via Chance Constrained method. The goal here is mainly minimization of losses, voltage dispatch problems and price for different classes of customers with regard for nuclear and new network design under RTO/ISO for sustainable, reliable and resilience market design.

The traditional decision support tool does not include regulatory reform by policy. This mission requires a new formulation of the impact modeling role will be suggested for developing the tools for dispatching and optimizing of enhancing market design to handle 2RS+A.

Summary of activities with respective approach is given in table 2 below.

Table 2: Summary of Activities and Approach in New Market Design

Activity	Traditional Grid	New Grid
Policy	▪ Provide grid to push pricing requirement ▪ Deny microgrid participation in the grid	▪ Provide a unified access of retail and wholesale market for all participants. ▪ Subsidy is not misused.
Regulation	▪ Only enforce distribution and transmission system user pricing	▪ Provide regulation that allow Virtual Power Plant (VPP)to participate in market. ▪ Enforce 2RS+A for wholesale and retail market.
Technology	▪ Limited to classical central dispatch algorithm based on LMP	▪ Includes microgrid and advanced features such as power electronics ▪ Data analysis of customer profile ▪ Dynamic stochastic optimization ▪ Ancillary services support of microgrid ▪ Control Coordination ▪ Visualization ▪ Job Opportunities

2.11.1. Co-Optimizing the Integrated Market Design

The overall proposed approach of Co-optimizing resources in a new market to achieve 2RS+A is discussed in Figure 2.3.

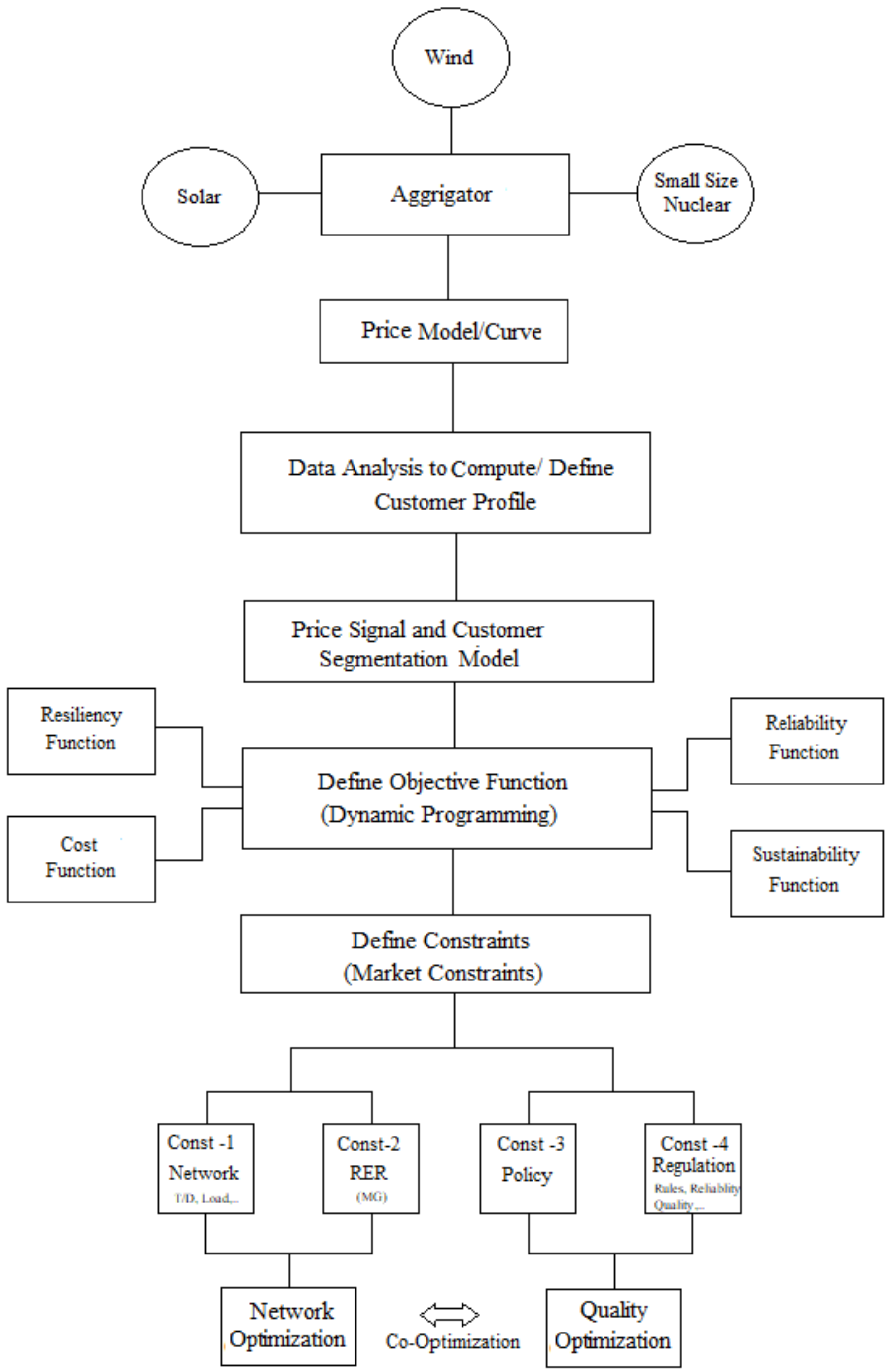

Figure 2.3: Approach to Co-Optimization of Resources

2.12. REVIEW ON INTERNATIONAL MARKET DESIGN

This section reviews the current practice by international market design in US, Africa, Europe, and Asia to have full understanding where the market is relative to the 2RS+A principal objectives. Then following key points must be looked up:

1. What the network design is and if it accommodates decarbonization and allow access to energy technology and also check the role of the national grid if any to accommodate RER and nuclear at state and interstate level.
2. The flaws if any in the pricing of electricity due to not incorporating customer segmentation.
3. From the review performed, every country does not have robust national grid. Until a national grid is achieved, so we propose the development of similar technology to support the 2RS+A multiple objective with full participants.

Microgrid at both state and federal level network to allow for improved penetration of RER (solar, wind, Nuclear) in the state and interstate to be able to meet approved regulation and policy and to let price be segmented that are acceptable to customers and market participants. Storage technologies are equally recommended in the design framework of policy, regulation, and customer choice of the delivery through distribution, microgrid or bulk power. The country policy must be rechecked and renovated to including inter regional markets. Therefore, the regulator must provide constant guidance that accepts the approved national network design with appropriate rule making which define the pricing signature incorporated in the new Security Constrained Clean Economic Dispatch Tools. Appropriate use of rules, control, visibility, and coordination must be put in place for efficient, sustainable, and intelligent market design.

Use of advanced optimization technologies to account for measurement, computation, communication, and control are defined as a separate section of the chapter. Data analysis used in design and classification of market participants. Whereas Artificial intelligence (AI) in reinforcement learning to learn the prediction of weather and extreme events which will determine local weather and hence determine the limitation or accessibility of network and availability of Renewable Energy Sources (RES).

Development of criteria for different virtual or distributed that leads to voltage control phases, local frequency problem and power quality problem are defined and given available control measures and reinforced learning optimization embedded in stochastic optimization (Robust optimization will be developed. The optimal solution will help to optimize the ancillary services provided by the coupling of microgrid in support of the future (modernized) grid for achieving the global objectives of optimizing with respect to 2RS+A. The policy and regulatory rules application to new market design based on 2RS +A an ongoing research at Howard univeersity

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2.13. CONCLUSION

In this chapter, we have redefined market in terms of multiple objectives, gathered data profile and a new national goal for State and Federal is developed. Also, it is recommended for market operators and experts to join with regulator in the new market design. The objective is put in a new formulation to achieve Reliability, Resiliency, Sustainability, and Affordability (2RS+A). Multiple players that contribute to meeting the 2RS+A objective are also identified. A new optimization tool is suggested and an integrated approach to co-optimize resources are proposed that need to use stochastic programming, data analytics and machine learning tools.