Tariff Schemes to Foster Demand Response (DR) = Energy Efficiency (EE) and Demand Side Management (DSM)

ANEEL
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Objectives of this Presentation

- Define Demand Response (DR)
- Provide a few examples on the use of DR in Brazil
- Compare DR in Brazil to other countries – developing and developed
- Discuss the role of technology
- Illustrate the potential of DR in Brazil
- Final remarks

What is Demand Response?

- Generally speaking, DR takes place when a customer changes its consumption patterns in response to a stimuli
- The nature of this stimuli is broad
  - Prices (tariffs) – average, Time of Use (TOU), real time
  - Other economic incentives – e.g. rebates on tariff authorizing load control on customer premises
  - Contracts – e.g. interruptible contracts
  - A social pact – e.g. consumers agreeing on having their incancandescent lamps replaced - Uganda and Rwanda (2006), rationing program in Brazil (2001)
  - Moral suasion – e.g. TV ads urging customers to reduce load during peak hours, in South Africa
  - DR can take place at different time intervals – from a few cycles to a few hours or a couple of months – with or without total consumption reduction
  - Energy Efficiency is a special kind of DR – the integral of MW reduction over a longer period of time (MWh)

This is not a new subject

- Many countries have been adopting tariffs and load control schemes for many years, fostering DR
- The subject has garnered more attention in the last 8 years – since the sequence of power crisis worldwide in 2001 2001 – in California, Brazil, Norway, New Zealand – followed by massive blackouts in the US and Europe
- More recently, triggered curiosity due to
  - Smart Grids
  - Climate Change and GHG reduction
- Enabling advanced technologies, at reduced costs – e.g. Smart meters, communication, internet
- And by the expressed interest of President Obama to address the energy challenges harnessing the potential of demand side

Brazil has been using DR mechanisms – price based and other types

- Time of Use Rates – with seasonal variation
- Interruptible contracts
- Increase in average tariffs and taxes
- Energy Efficiency and R&D tariff levies
- Wholesale energy market, with zonal prices and time-differentiated spot prices

However, there are important challenges to confront

- Different criteria resulting from the application of TOU rates and the ones resulting from the application of spot prices (added to use of network charges and losses – showing a price distortion in peak hours
- This is due to the fact that transmission is priced differently, creating non-economical bypass and arbitrage opportunities
- Zones (sub-markets) are too large to provide a differentiated price signal on where load reduction is more necessary
- Out-of-merit dispatch weakening the price signal for load reduction – in areas where it would be more beneficial to the system
- Low-income tariffs (lifeline rates) are not well targeted and do not foster energy consumption
- Time of Use Rates have evolved in the world – but it continues to be very rigid in Brazil, at fixed intervals and not reflecting system criticality – Critical Peak Pricing (CPP) and Real Time Pricing (RTP) not yet implemented

Which leads us to the following question – Are those instruments producing intended results? In many cases, yes.

- The introduction of TOU rates about three decades ago, adopting the EDF model (blue and green tariffs) had a positive impact on shifting peak load (perhaps exagerated)
- Interruptible contracts helped monetize a temporary excess energy which would be otherwised spilled away
- Likewise, the establishment of the wholesale energy market (CCEE), consolidation of retail competition, and increase in the role of marketers have helped allocate energy effectively
- The 2001 power crisis was considered a "best practice." – a 20% load reduction, almost nation-wide, without a single black-out or brown-out
- Which has been recommended by the World Bank to several countries facing power shortages - Uganda, Argentina, South Africa, Turkey, Pakistan, Ethiopia – but not always adopted, given its apparent complexity, lack of leadership from the governments, or lack of system commercial discipline (non-technical losses)

The most recent and important uses of demand response to deal with power crisis took place in Brazil and California

	California (1)	**Brazil** (2)
Shocks	Supply and Demand	Supply
Shortage	Capacity (Energy)	Energy only
Action	20/20	Cap (and Trade)
Mandate	Voluntary	Compulsory
Load Shedding?	Some	No
Duration	11/00 - 05/01	6/01 - 02/02
Government Action	Slow	Fast
Cost of Demand Response	US$276/kW-yr	US$7/MWh
Second Best	US$55/KW-yr (peaking) or shedding	US$150/MWh or shedding (US$300/MWh)
Metering Deployment	No	No

(1) Sweeney, J. *The California Electricity Crisis* . Stanford - CA. The Hoover Institution Press, 2002.

(2) Maurer, Pereira, Rosemblatt. *Implementing Power Shortages in a Sensible Way: Lessons Learned and International Best Practices* . Washington DC. ESMAP. Report 305/05. 2005.

Some countries have adopted the Brazilian crisis management scheme

Interventions to address electricity shortages

January 2008

NATIONAL RESPONSE TO SOUTH AFRICA'S ELECTRICITY SHORTAGE

Power Conservation Programme

The concept proposal for the PCP draws heavily from the publication, "Implementing Power Rationing in a Sensible Way: Lessons Learned and International Best Practices (ESMAP Report 305/05, August 2005)", which commends the energy rationing applied in Brazil in 2001 as best practice in the event of an energy crisis. The key elements of the programme would be as follows:

And cited as an example of “pushing the envelope” on rate design

III. Brazil’s Two-Part Rate Design

Contrary to conventional wisdom, new ideas can flow north in the Americas, not just south. An alternative way of lowering consumption during times of crises that would be much more economically efficient than the examples discussed above is a program that was pioneered in Brazil during its power crisis in 2001.[8] Brazil, which generates 80 percents of its energy from hydroelectric resources, faced a generation shortfall of 20 percent caused by drought. Decision-making in Brazil was not hampered by the political considerations that have prevented economically efficient pricing by commissions in the U.S. Brazil developed a rate program that gave customers a two-tier rate signal. Customers were charged the standard rate for consumption up to a pre-set limit and charged a higher price based on marginal costs for usage above the limit. Brazil established mandatory targets for saving energy that varied by sector. Low household users that consumed less than 100 kWh had no savings target. All other households had a target of 20 percent (i.e., a pre-set limit of 80 percent). Industries and government buildings had targets that varied between 15 and 25 percent, while public lighting had a target of 35 percent. To lower demand, it instituted penalties and incentives. For example, customers who did not meet the targets were subject to interruption of supply. In addition, consumption in excess of the quota was subject to price increases of 50 percent for customers in the 210–500 kWh

How does Brazil compare with other developing countries? Reasonably well.

- There are significant efforts abroad to foster EE – however, fewer in terms of DSM, where the potential of price signals are often under-explored
- TOU are common in many countries, but absent in others – leading to a notable inefficiency in the use of capital – e.g. Saudi Arabia, where some plants are dispacthed for 20 yours per year !!
- In the absence of price signals, actions on load control are common – for example, introduction of millions of CFLs in Sub-Saharan Africa – e.g. Ethiopia or South Africa, where the average tariff is US 5 cents/kWh while the short run marginal cost is US 30/kWh.
- In some cases, countries prefer to increase significantly the average tariffs in time of crisis – e.g. Uganda, tripling from US 6 to US 18 cents per kWh. In a kind of "brute force" approach at least to cover total costs and minimize fiscal impact
- Many EE programs are driven by green house gases reduction, with less emphasis on DSM -- e.g. Original design of the efficient lighting and refrigeration program in Mexico (250 million CFLs)

South Africa is ahead of most developing countries in terms of Demand Response

DRAFT FOR DISCUSSION

Complementary Demand Driven Programs do Deal With Long Term Power Crunch in South Africa (1)

Discussions with the World Bank - February 2008

	Rationing	Energy Efficiency	Demand Side Participation
Approach	"Quasi-Market Based Rationing"	Standard Offer	Demand Response - Reliability (and possibly Economic)
Product	MWh and indirectly MW reduced	MWh and indirectly MW reduced	MW (capacity) reduced in different timeframes (cycles to days). Negligible on MWh
Primary Target Market	All customers at the outset	Medium and large. Smaller with "aggregators"	Primarily large
Incentives	Bonuses, penalties, disconnection, differentiated quotas per customers group	Fund to subsidy, Difference between price paid and regulated tariff (per kWh). Differentiated by technology	Pecuniary incentives for Reliability and Economic. Differentiated by speed of response.
Safety Net for the Poor	No Quotas, only bonuses	Programs targeting poor customers (e.g. efficient appliances)	Not applicable
Speed of implementation and load response	Very short term	Medium and long term	Short term

How does Brazil stand vis-a-vis developed countries? In this regard, there is still a lot to learn, respecting structural differences

US – one of the most advanced countries in terms of DR – a key ingredient to properly operate a thermal dominated, peak-constrained power system

- DR is obtained via price mechanisms, load control or a combination thereof
- There are many pilots demonstrating that there is price-elasticity among residential customers, and this may be harnessed to entertain demand response
- There are hundreds of programs, mechanisms, incentives, tariffs, rebates and players – the latter ranging from independent system operators (ISO, RTO) to load curtailment providers – a new breed of marketers responsible for aggregating granular DR
- Some of those programs are extremely effective as ancillary services, able to respond in a few seconds – e.g. air conditioning cycling
- FERC Order 719 on market rules – spells out that auctions to acquire any energy related product should accept demand side participation

In the US, TOU has been gradually replaced by new time based tariff mechanisms, more adherent to system criticality

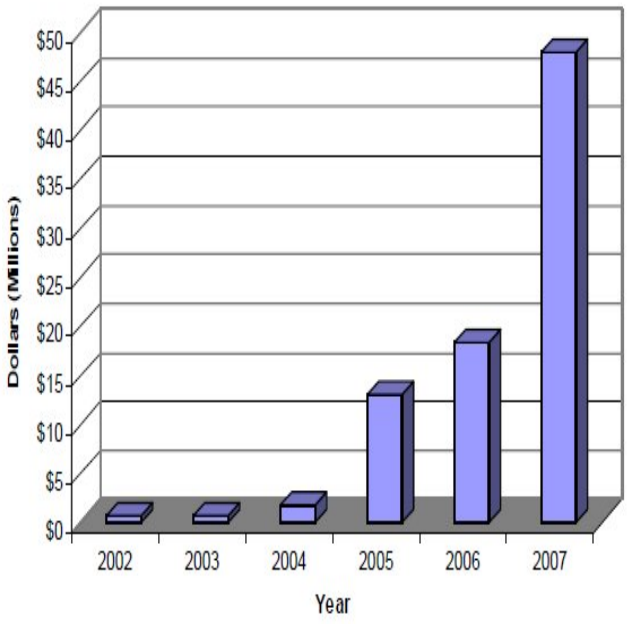
Table III-1. Number of entities offering time-based rates

Time-based Rate	Number of Entities (2006 Survey)	Number of Entities (2008 Survey)
Time-of-Use Rates	366	315
Real-time Pricing	60	100
Critical Peak Pricing	36	88
TOTAL	462	503

Source: 2006 FERC Survey and 2008 FERC Survey

A new breed of marketers - Curtailment Service Providers" has the potential to reduce transaction costs

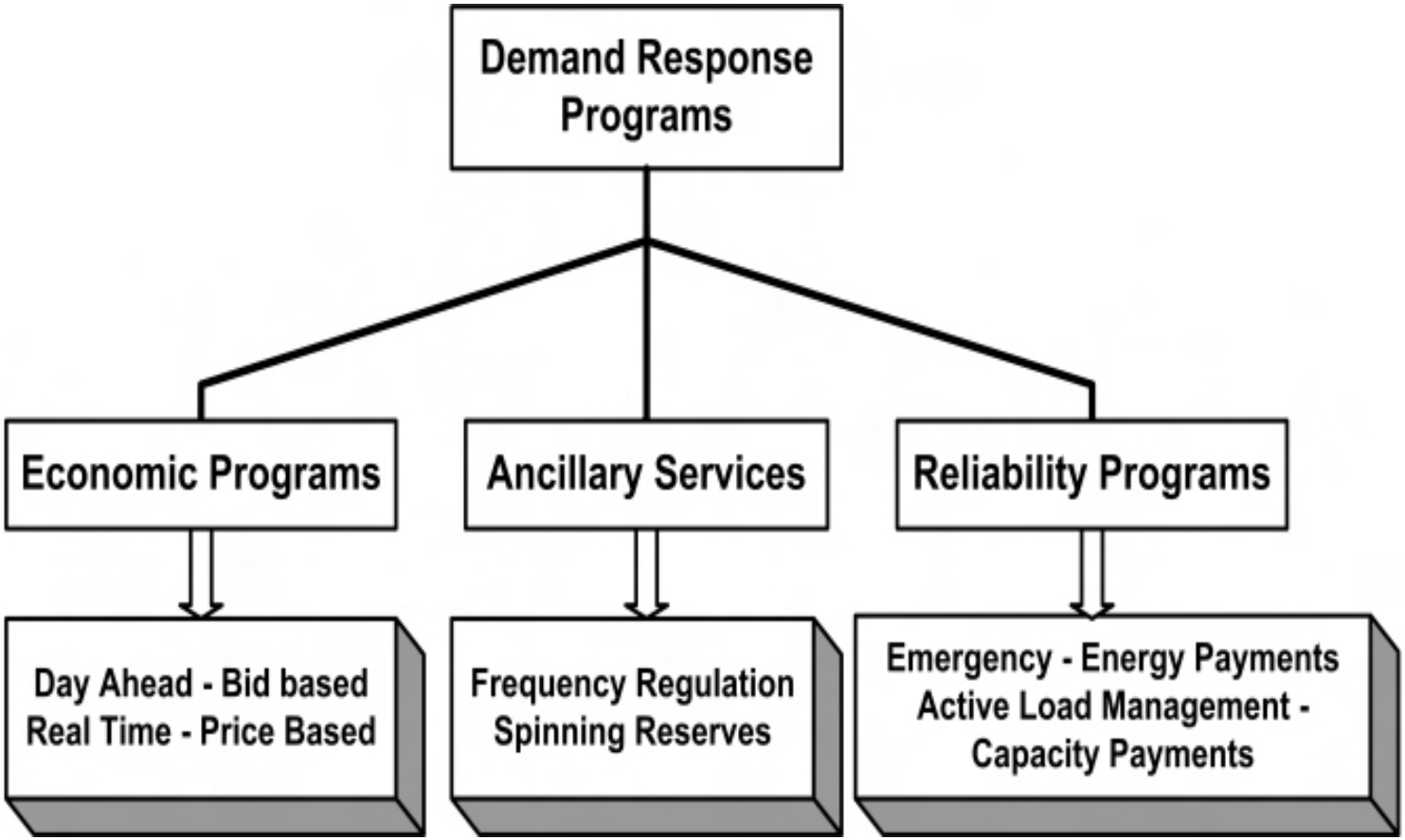
Figure IV-1. Annual energy payments to curtailment service providers for economic activity in PJM



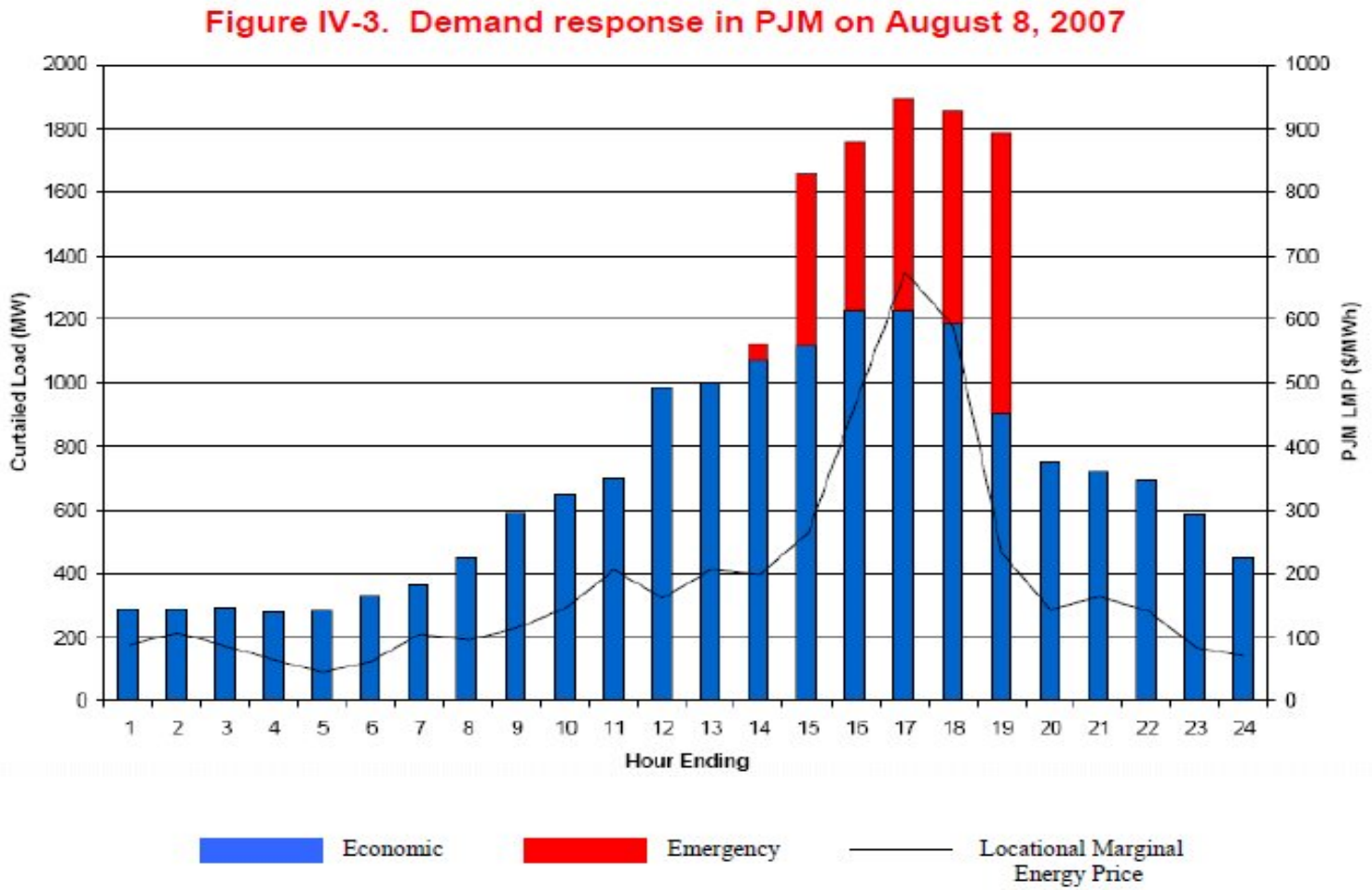
Source: Presentation by Susan Covino, PJM at National Town Hall Meeting on Demand Response, June 3, 2008.

- Institutionalized
- Increasing role (see graph, for PJM Power Pool)
- There are no conflict of interests
- A broad range of players – e.g. Credit Suisse, Suez, National Grid, Hess, HSBC, etc.

The DR programs reduce energy cost, provide ancillary services and contributed to increase system reliability



Example of Economic Response in PJM power pool – many customers willing to curtail if spot price > US$75/MWh (blue bars)



Would this help Brazil, which is predominantly hydro?

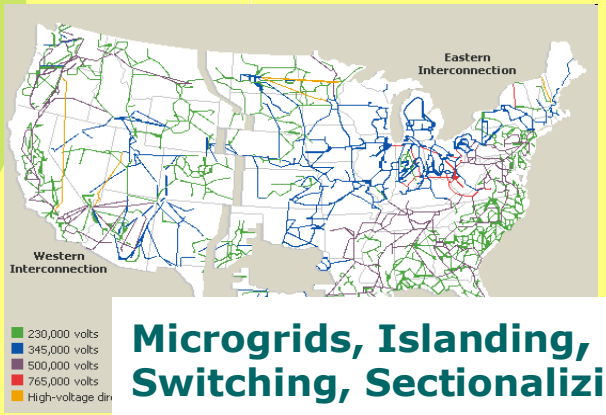
- Yes, but in different shapes and forms – DSM programs are more effective in peak-constrained systems
- However, even in hydro systems, plants with high variable cost are being dispatched today – this cost (more than US$ 1 bi in 2008) could be mitigated via an economic DR program
- The discussion about System Service Charge (ESS) gains a new dimension – today is who should pay the bill, but it should be focused on how to reduce it with proper DR interventions
- Even in hydro systems there are transmission contraints that need to be managed
- An illustrative example – the electric shower – in the absence of residential TOU (yellow tariff), a selective load control (e.g. Ripple control) could bring benefits in some concessions
- This would be equivalent to what is being done for water “geysers” in South Africa, studied for injera baking stoves in Ethiopia, and extensively applied to residential air conditioners in the US
- Reliability gains benefit both thermal and hydro systems

What is the role of technology?

- Technology is not an end on itself – it is an enabler to DR initiatives which would be more difficult to obtain otherwise
- Two critical areas – metering and two-way communication
- Pre-paid meters – e.g. 7 million in South Africa – a large display in the customer's premise help monitor consumption and save energy
- Some countries are considering leapfrogging and migrating directly to smart meters (today's cost of US$ 300 per customer) – including pre-paid features, fraud control, AMR and features to manage load – e.g. automatic switching of non-esssential loads (or cycling)
- Smart grid – a buzzword today – main aspect to keep in mind – the most important thing in a smart grid is to have a smart customer

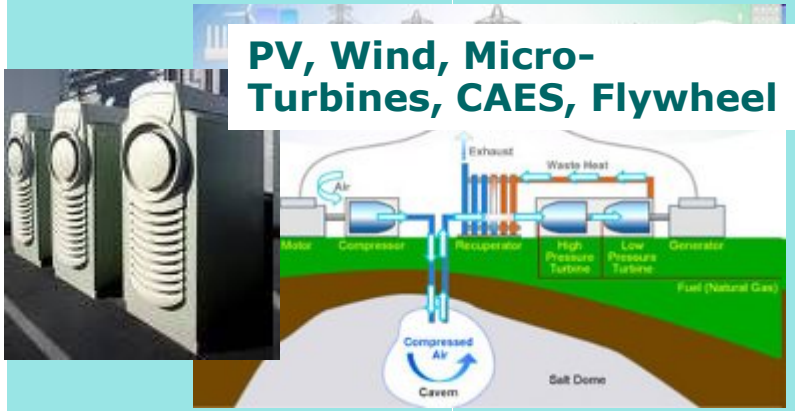
A smart customer – able to feel and respond – to prices, load control instructions, under frequency devices installed on appliances, etc.

Intelligent Transmission and Distribution Automation



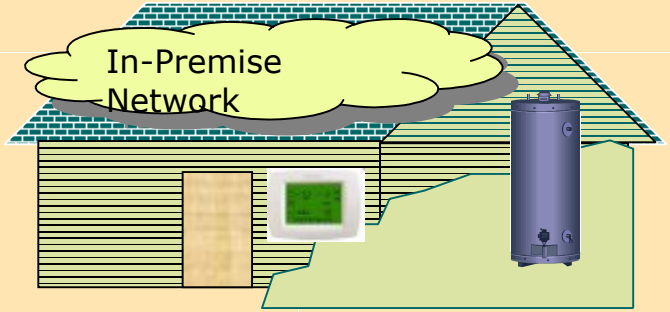
Microgrids, Islanding, Switching, Sectionalizing

Distributed Generation and Storage



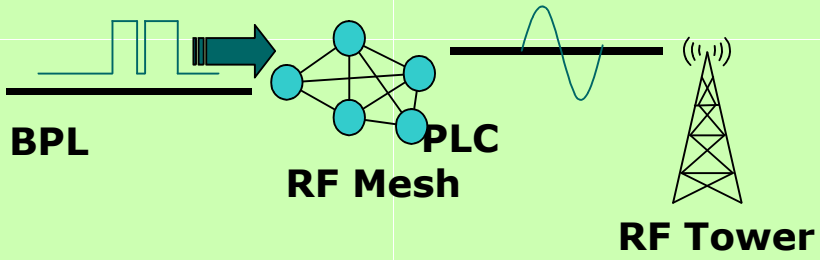
PV, Wind, Micro-Turbines, CAES, Flywheel

Demand Response & Control



In Premise Networks, Automated DR, Integrated Demand-Side Resources

Advanced Metering Infrastructure



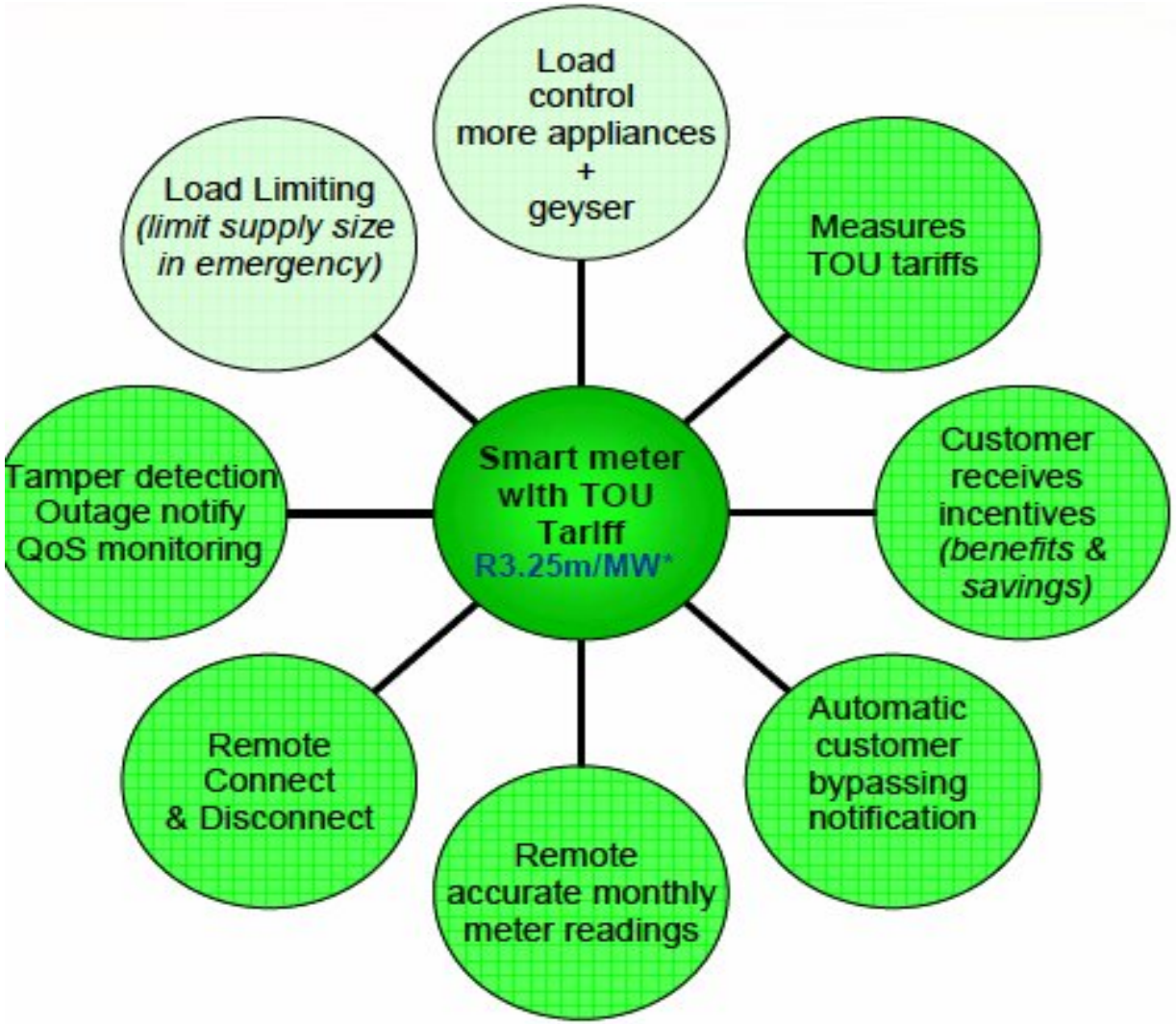
Reading, Remote Disconnect, Capacitor Controls, Sensors, Wastewater

Smart Meter – Important enabler to the adoption of of new tariffs – e.g. TOU, critical peak pricing, real time pricing

Enabling a full range of demand side interventions for virtually every customer

Customer Type	Equipment / Building Component	Control Strategy	DR Programs		
			Emergency (Capacity)	Economic (Energy)	Ancillary (Reg & Res)
Residential	Air Conditioners	Cycling/Forced Demand Shedding	✓	✓	✓
	Water Heaters	Cycling	✓	✓	✓
	Pool Pumps	Cycling	✓	✓	✓
Commercial	Chillers	Demand limiting during on peak period	✓	✓	
	Chillers HVAC	Pre-cool bldg over night- storage		✓	
		DX Forced Demand Scheduling	✓	✓	
	Refrigerator/	Prioritized Demand Shedding		✓	
	Lighting	Scheduled dimming of selected circuits		✓	
Industrial	Chillers	Demand Limiting on time Schedule		✓	
	Electric Furnace	Demand Limiting through Heat Stages		✓	✓
	Electric Furnace VSDs	Curtail (during peak period)	✓	✓	✓
		Limit Output on Scheduled basis		✓	
	Production Eqpt	Prioritized demand on selected units		✓	

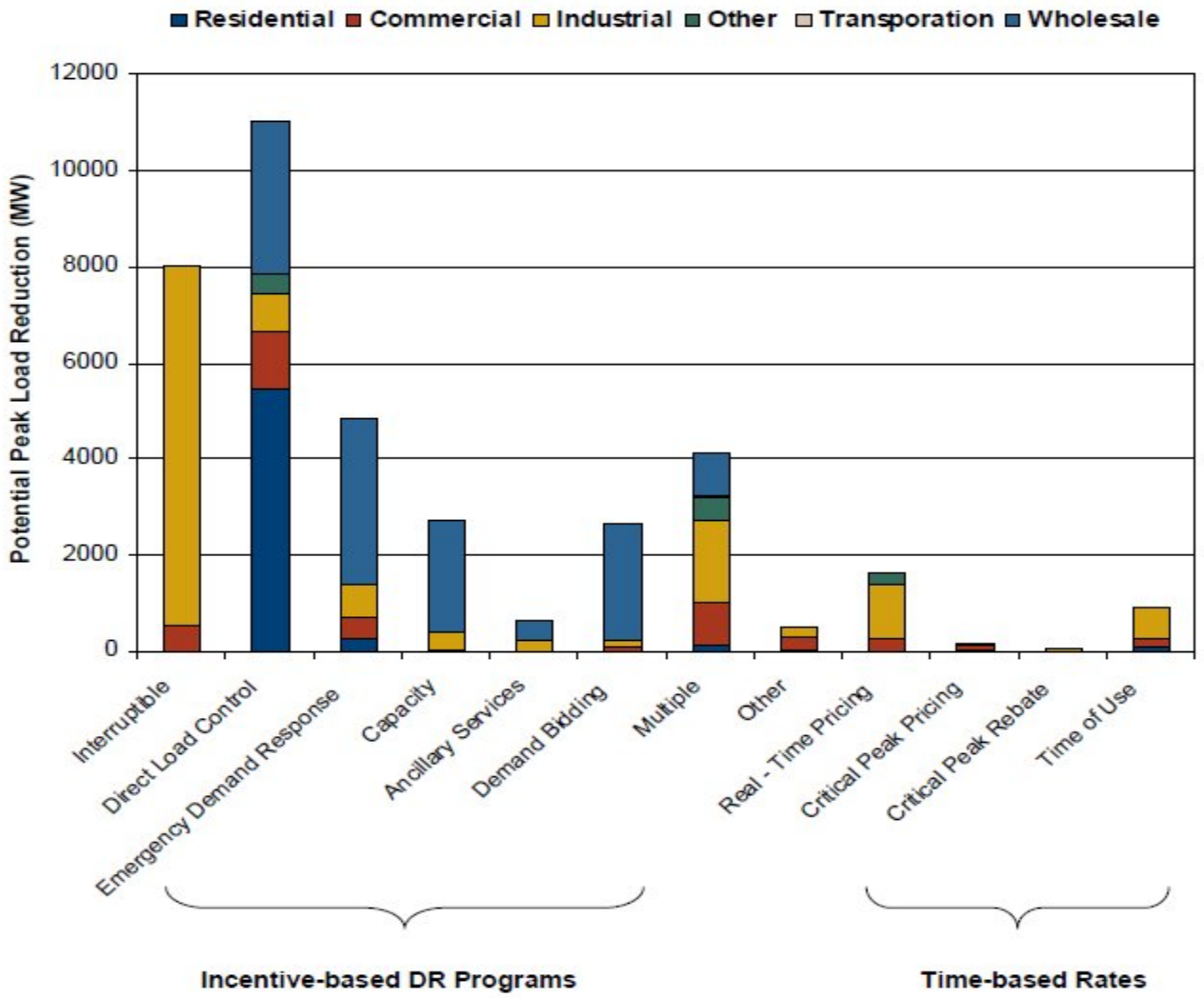
Business case – has to be built incrementally, condidering DR and non-DR costs and benefits



Brazil offers a great potential to harness DR opportunities

- Brazil can take advantage of its rich DR experience during the 2001 rationing – for example, by offering tariffs that transfer part of the price risk to the customer – e.g. NERA Fi-Va, or "negotiated quotas"
- A more modern metering system would increase customers' awareness to the total and time-profiled consumption (e.g. 7 milion pre-paid meters in RSA)
- The energy auctions should contemplate both generation and load reduction possibilities, therefore increasing competitiveness (e.g. Demand Side Bidding originally part of MAE rules in 1998)
- Lifeline rates could be means-based only – relying on one of the most effective target mechanisms in the world (bolsa familia) – and provide a fixed rebate on the bill, to foster efficient consumption from the very first kWh
- More intensive use of DR mechanisms to increase system reliability at low cost
- As well as reduce or postpoie capital investments to expand the sub-transmission and distribution systems
- Others, to be identified

Best mix between tariffs (time based rates(and load control? A decision which should be carefully analyzed



Final Remarks

- Demand Response is a key instrument available to the power sector and its customers
- New methodologies and prices (tariff-based) are important ingredients of a well designed DR program
- Brazil has many interesting experiences to report
- But still a lot to learn and benefit from
- There are interesting experiences out there – a few in developing countries (e.g. RSA) and many in developed countries
- The power sector in Brazil has pioneered and been on the leading edge in many areas - this is potentially one more, with significant potential
- To achieve results, it is necessary to revisit, with an open mind, the concept of customer relation, objectives to be achieved with DR, and new generation tariff schemes
- ANEEL has a key role to play to make things happen – ONS and CCEE are key beneficiaries