Energy and the Built Environment
CRP 470.004 /570.004

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Lecture 7

Electricity industry

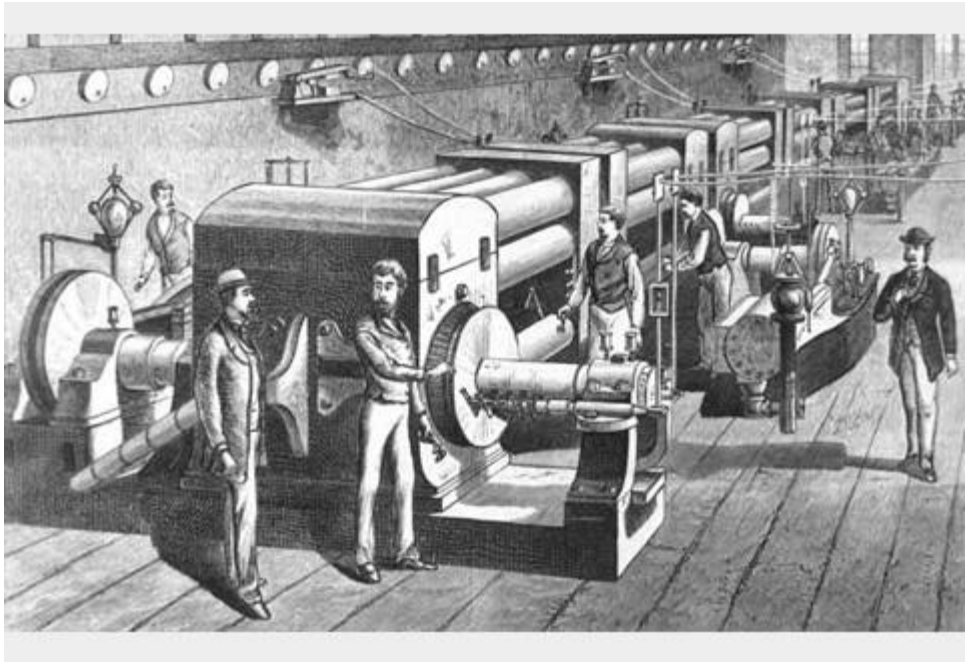
Outline

- Evolution of electric utility industry
- Regulation
- Pricing
- Load profile, load duration curves, baseload and peaking plants
- Example looking at PNM
- MIDTERM Exam –take home, 3/11

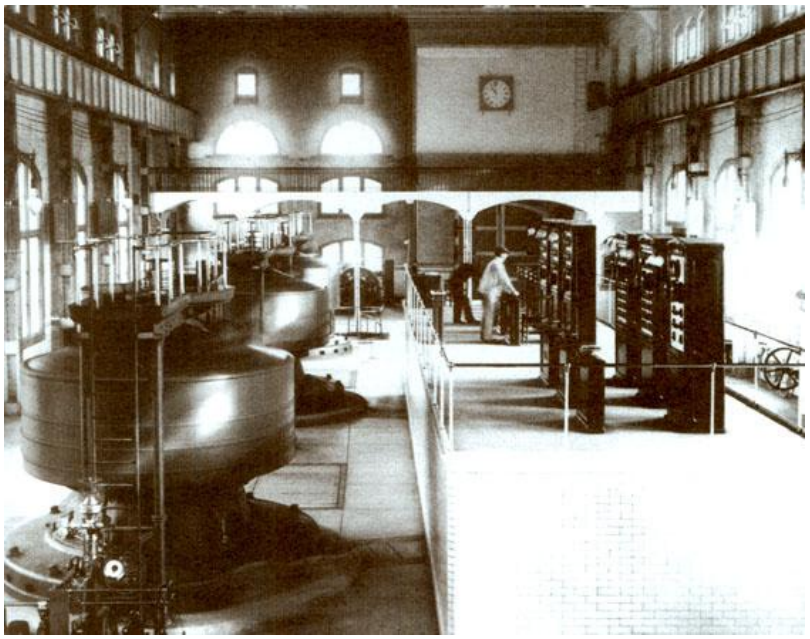
1882	Edison's Pearl Street Station opens
1883	Transformer invented (L. Gaulard and J. Gibbs)
1884	Steam turbine invented (C. Parsons)
1886	Westinghouse Electric formed
1888	Induction motor and polyphase AC systems (N. Tesla)
1889	Impulse turbine patent (L. Pelton)
1890	First single-phase ac transmission line (Oregon City to Portland)
1891	First three-phase ac transmission line (Germany)
1903	First successful gas turbine (France)
1907	Electric vacuum cleaner and washing machines
1911	Air conditioning (W. Carrier)
1913	Electric refrigerator (A. Goss)
1935	Public Utility Holding Company Act (PUHCA)
1936	Boulder dam completed
1962	First nuclear power station (Canada)
1973	Arab oil embargo, price of oil quadruples
1978	Public Utilities Regulatory Policies Act (PURPA)
1979	Iranian revolution, oil price triples; Three Mile Island nuclear accident
1983	Washington Public Power Supply System (WPPS) $2.25 billion nuclear reactor bond default
1986	Chernobyl nuclear accident (USSR)
1990	Clean Air Act amendments introduce tradeable SO_2 allowances
1992	National Energy Policy Act (EPAct)
1998	California begins restructuring
2001	Restructuring collapses in California; Enron and Pacific Gas and Electric bankruptcy

Developing economies of scale

- Very expensive capital investment – how to raise capital?
- Large fixed costs, so you want to maximize run time



Edison Electric Illuminating Co., NY, 1882



Adam's Power Station, Niagra Falls, 1926

Regulation

- Natural monopolies
- How to stop from charging unfair prices?
  - Regulation by Federal Power Commission (FPC)
  - Rates are determined by costs
- Revenue Requirement = Rate Base x Rate of Return + Operating Expenses
  - Rate base is total of investments to serve customers

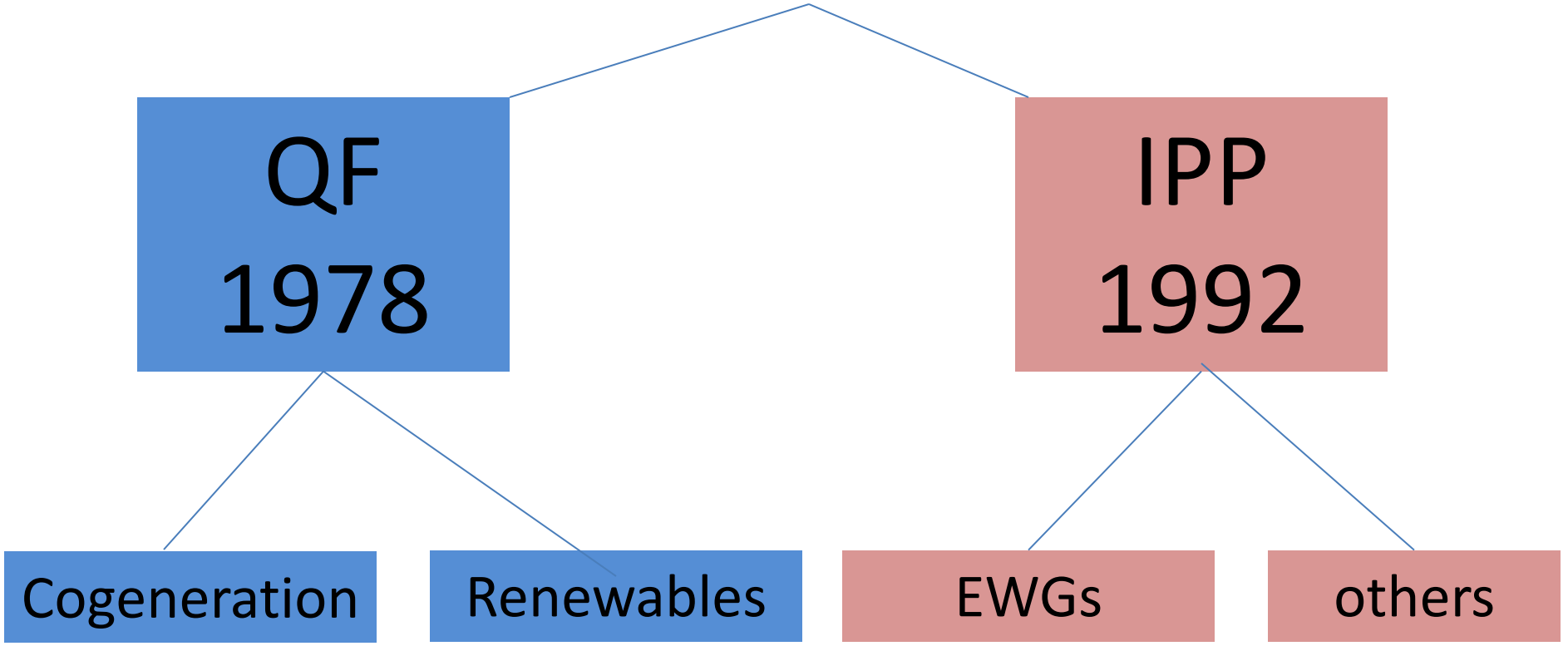
Landmark Legislation

- 1935 - Public utility holding co. act PUHCA and Federal Power Act
  - Limited holding co., and regulated utilities
- 1978 – Public utility regulatory policy act (PURPA)
  - Law requiring IOUs to purchase power from qualifying facilities (QFs) at avoided costs of generation
  - Also established independent power producers (IPP)
  - Federal energy regulatory commission (FERC), replaced Federal power commission (FPC) (in 1977)
- 1992 – Energy Policy Act (EPACT)
  - Created exempt wholesale generators (EWGs)
- 1996 Order 888
  - Regulated charges on transmission
  - Established independent system operator (ISO)

Utilities

1. Investor owned utilities (IOUs)
   - 5% of utilities, but over 65% of electricity, 75% of transmission)
2. Publically owned utilities (POUs)
   - Federally owned utilities – Tennessee Valley Authority
   - State/Municipal - Santa Fe Municipal Elect
3. Rural electric cooperatives (21 in NM)

Non utilities (generators)



Showed that economies of scale no longer was true, and small generators could operate profitably

Set the stage for deregulation and the fracturing of vertical integration

Transmission and distribution

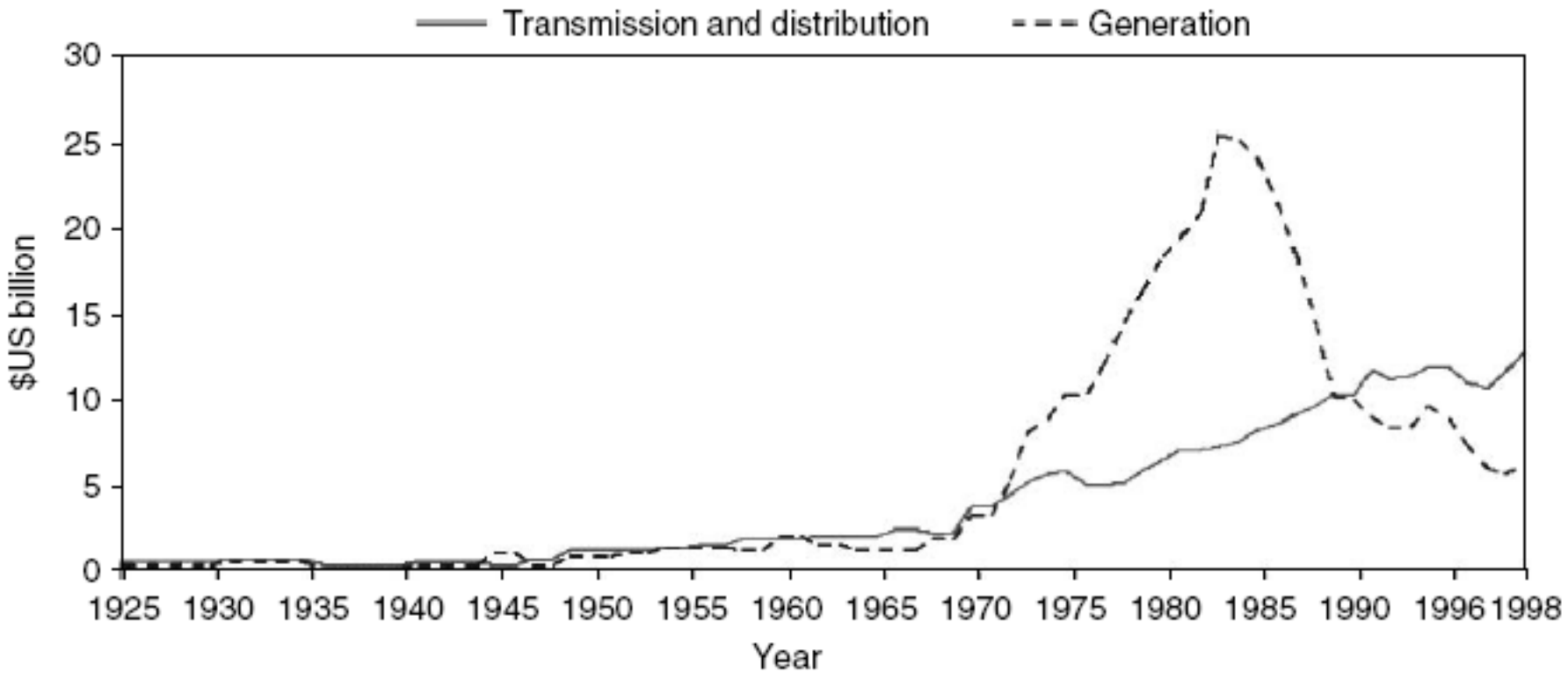
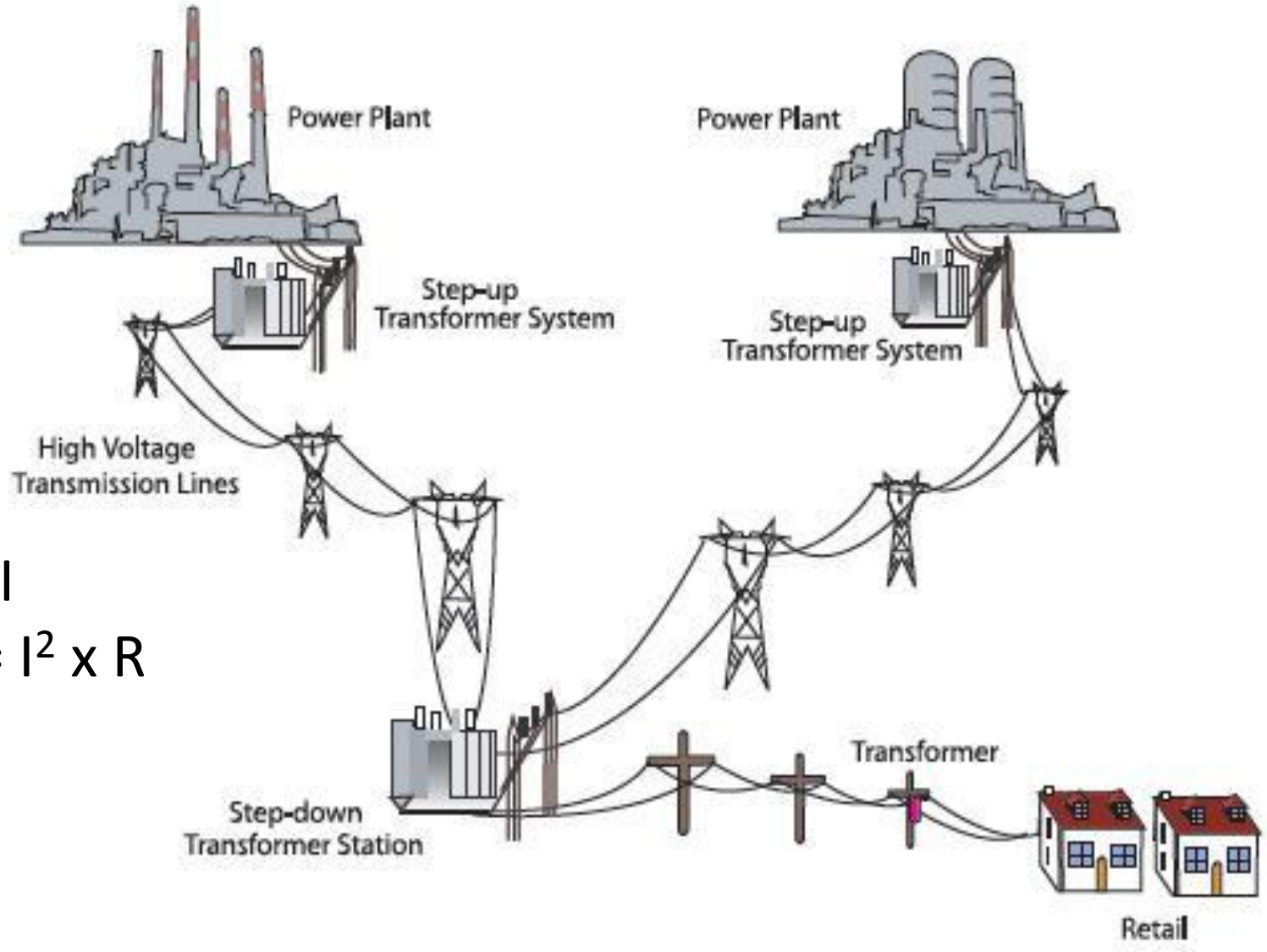


Figure 3.33 Transmission and distribution (T&D) construction expenditures at U.S. investor-owned utilities compared with generation. Except for the anomalous spurt in power plant construction during the 1970s and early 1980s, T&D costs have generally exceeded generation. From Lovins et al. (2002), using Edison Electric Institute data.

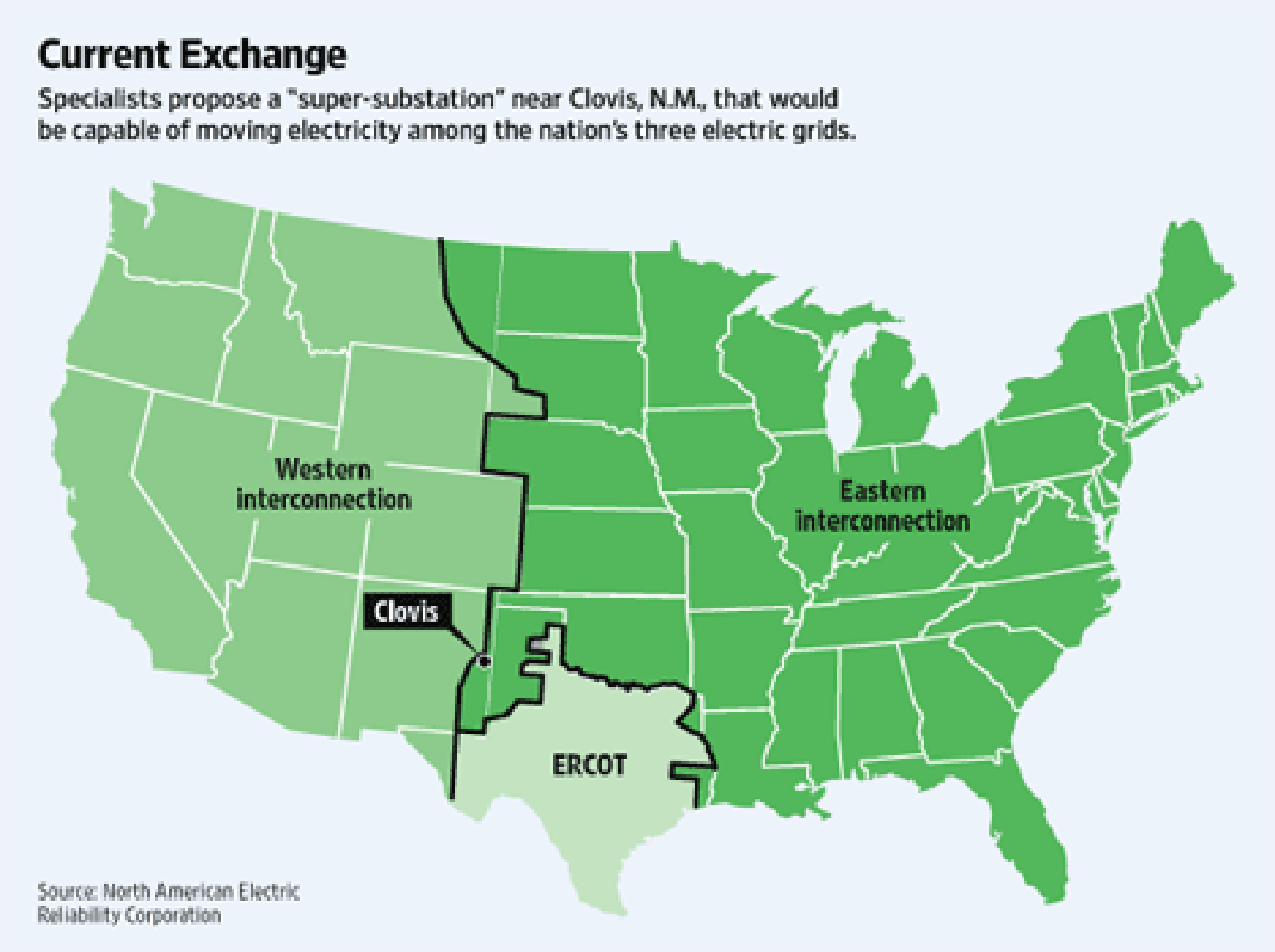
Transmission and Distribution



Power = V x I

Power loss = I^2 x R

3 separate power grids

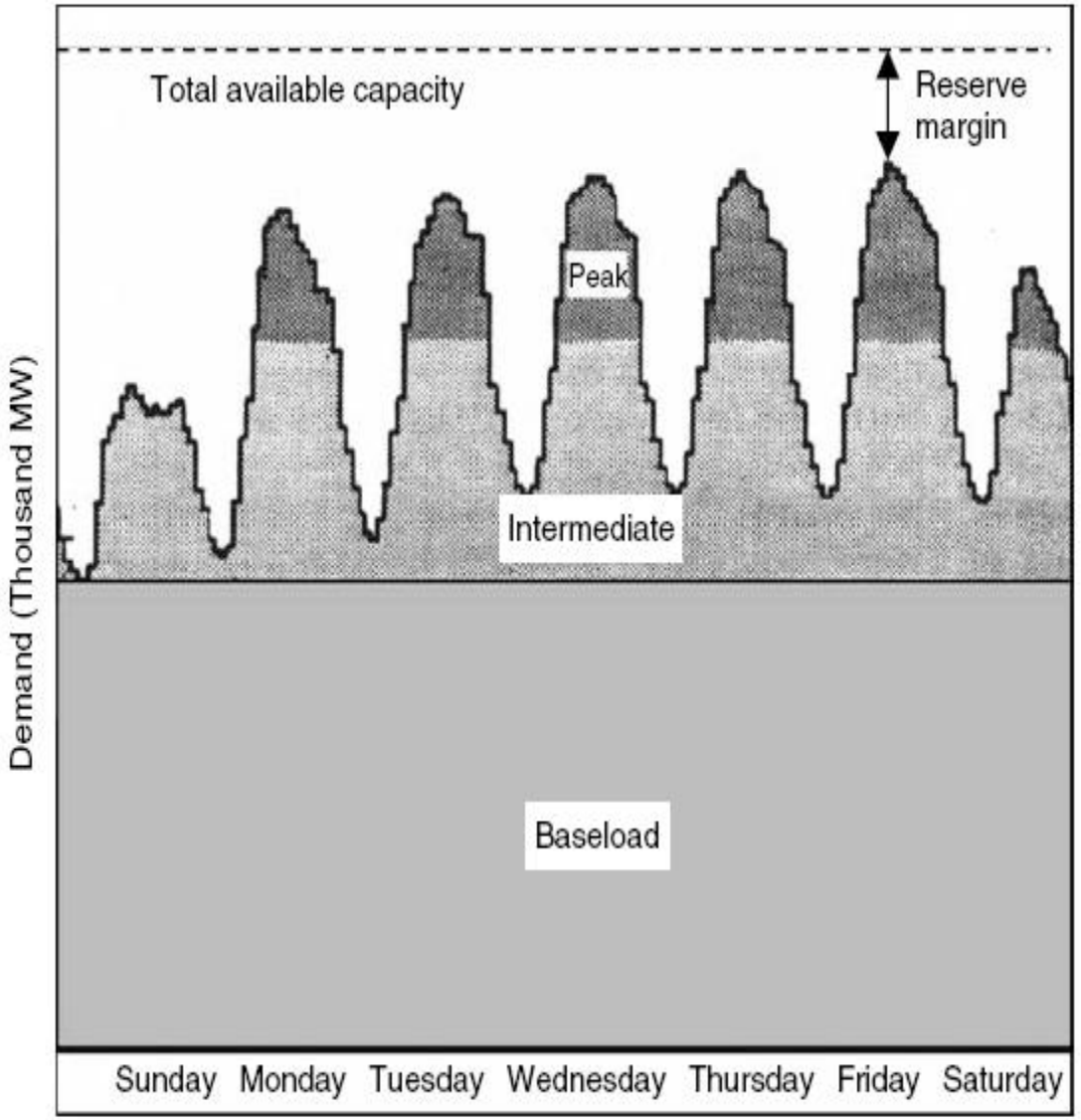


Utility planning

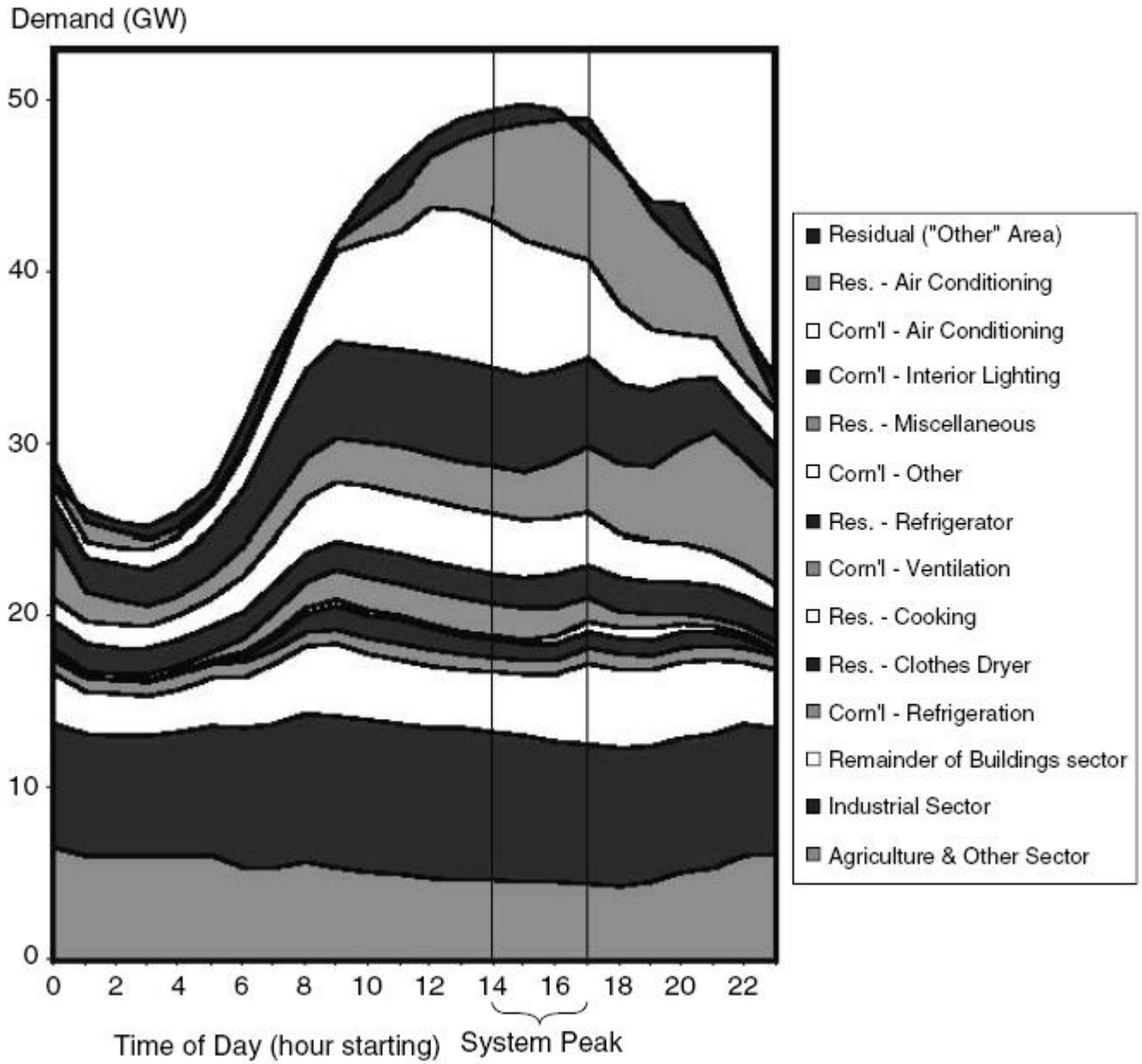
- How to meet demand at the least cost and greatest reliability
- Integrated resource planning (IRP) is now required for regulaties

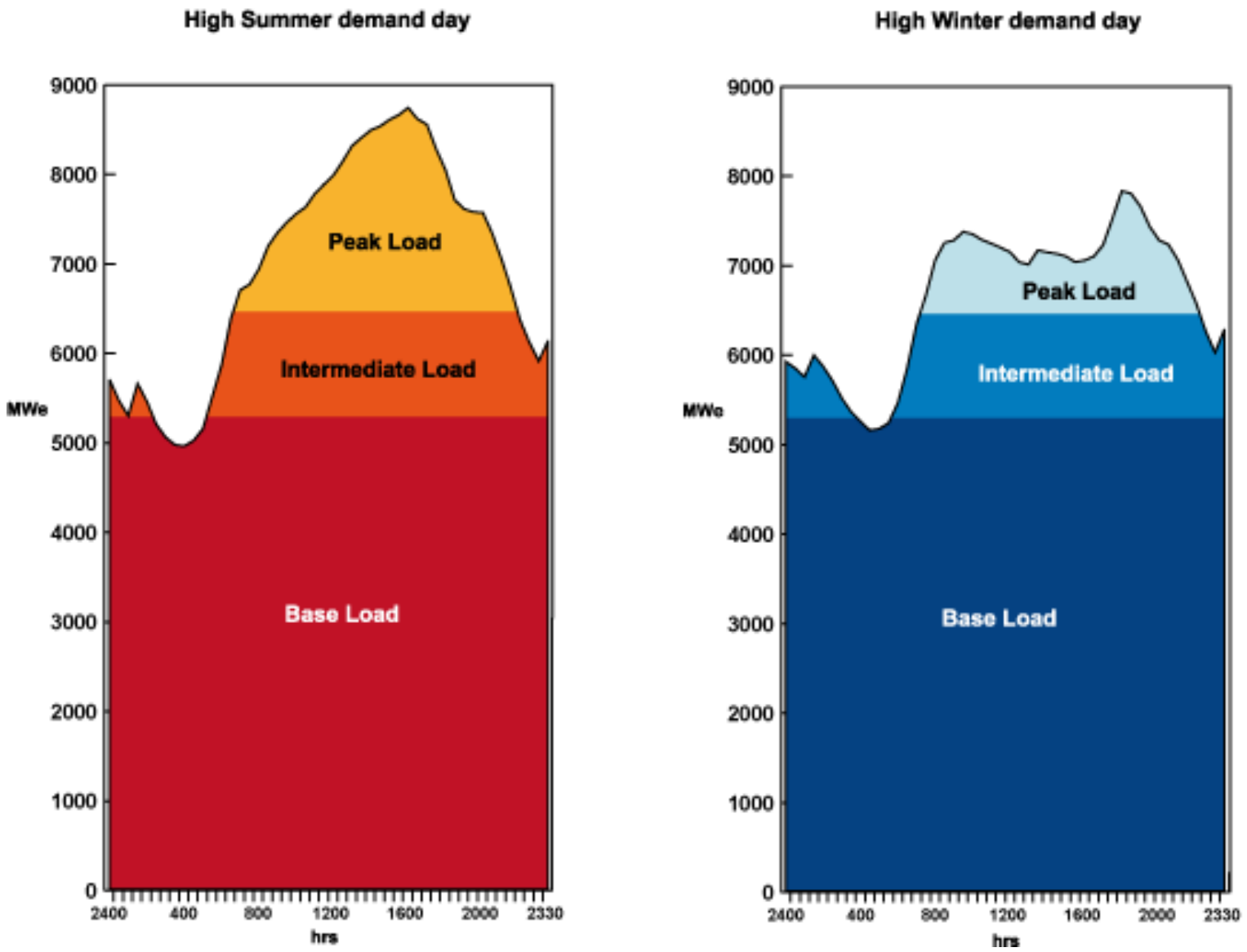
3 classes of generation

- Baseload – high capital costs, low operating costs (coal, nuclear, hydro)
- Intermediate (combined cycle turbines)
- Peak (simple cycle gas turbine)



Typical summer load profile





http://www.world-nuclear.org/info/Energy-and-Environment/Renewable-Energy-and-Electricity/

Pricing

- Bill = Fixed charge (covers fixed costs, like meter, billing, equipement,…) + energy charge
- Inverted (increasing) block rate tariff – pay more as you consume more (incentive to conserve)
- Industrial/commercial consumers typically have a demand charge based on peak power demand.

Residential inverted block rate structure (PNM)

IN THE BILLING MONTHS OF:	June, July and August	All Other Months
(A) CUSTOMER CHARGE: (Per Metered Account)	$5.00/Bill	$5.00/Bill
(B) ENERGY CHARGE:		
First 450 kWh per Month	$0.0906237/kWh	$0.0906237/kWh
Next 450 kWh per Month	$0.1373455/kWh	$0.1185101/kWh
All Additional kWh per Month	$0.1576960/kWh	$0.1283520/kWh

Time of Use Pricing (PNM)

IN THE BILLING MONTHS OF:	June, July and August	All Other Months
(A) CUSTOMER CHARGE: (Per Metered Account)	$20.81/Bill	$20.81/Bill
(B) METER CHARGE: (Per Metered Account)	$5.29/Bill	$5.29/Bill
(C) ENERGY CHARGE: On-Peak Period:	$0.2064384/kWh	$0.1607211/kWh
Off-Peak Period	$0.0663188/kWh	$0.0663188/kWh

EFFECTIVE

AUG 21 2011

REPLACED BY NMPRC
BY F10 Case #10-00086-UT

Advice Notice No.425

Gerard T. Ortiz
Executive Director, NM Retail Regulatory S
GCC

General power service time-of-use (PNM)

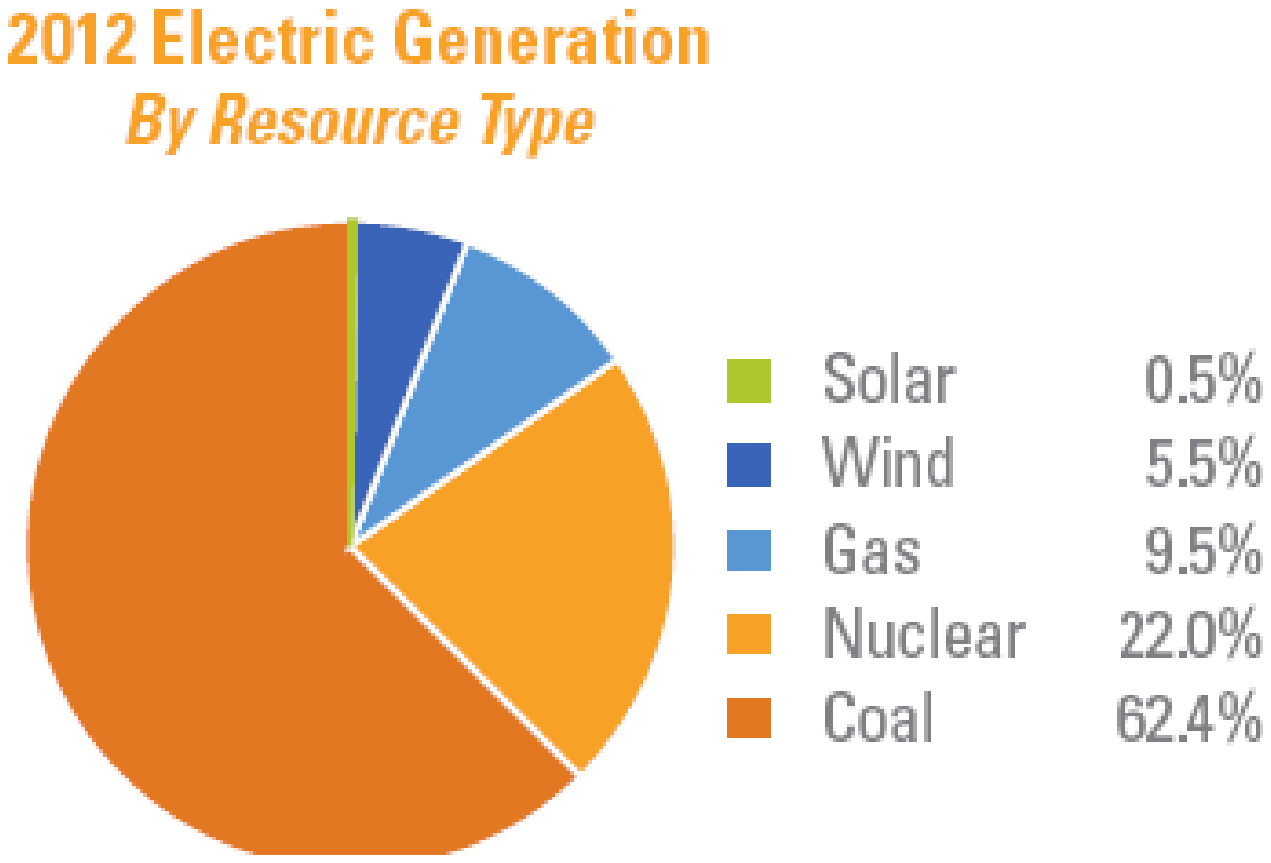
IN THE BILLING MONTHS OF:	June, July and August	All Other Months
(A) CUSTOMER CHARGE:		
Customer Owned Transformer (Per Metered Account) (Includes up to 1st 50 kW of Billed Demand)	$857.00/Bill	$638.50/Bill
PNM Owned Transformer (Per Metered Account) (Includes up to 1st 50 kW of Billed Demand)	$873.50/Bill	$655.00/Bill
(B) ON-PEAK DEMAND CHARGE:		
Customer Owned Transformer (For Billing Demand above 50 kW during On-Peak Period)	$17.14/kW	$12.77/kW
PNM Owned Transformer (For Billing Demand above 50 kW during On-Peak Period)	$17.47/kW	$13.10/kW
(C) ENERGY CHARGE:		
On-Peak kWh	$0.0844232/kWh	$0.0699376/kWh
Off-Peak kWh	$0.0393037/kWh	$0.0393037/kWh

Real time pricing (example)

- *“Real-time pricing" means tariffed retail charges for delivered electric power and energy that vary hour-to-hour and are determined from wholesale market prices using a methodology approved by the Illinois Commerce Commission.*
- Real-time electricity pricing requires the installation of an electricity smart meter that can send and receive information about electricity costs and give consumers more information about their own usage.

http://www.galvinpower.org/power-consumers/act/real-time-illinois/faq

PNM's IRP


2012 Electric Generation
By Resource Type
Solar 0.5%
Wind 5.5%
Gas 9.5%
Nuclear 22.0%
Coal 62.4%

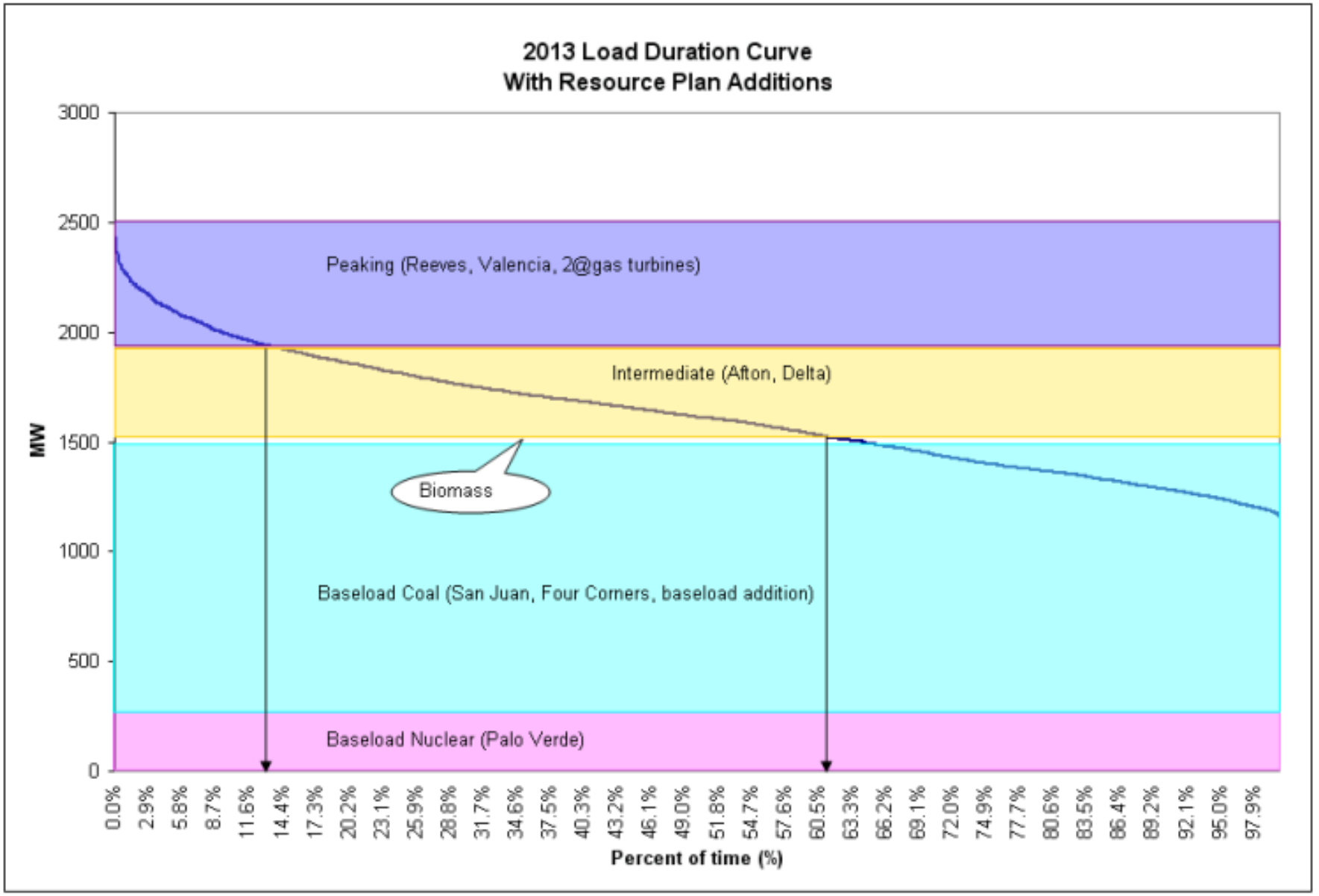
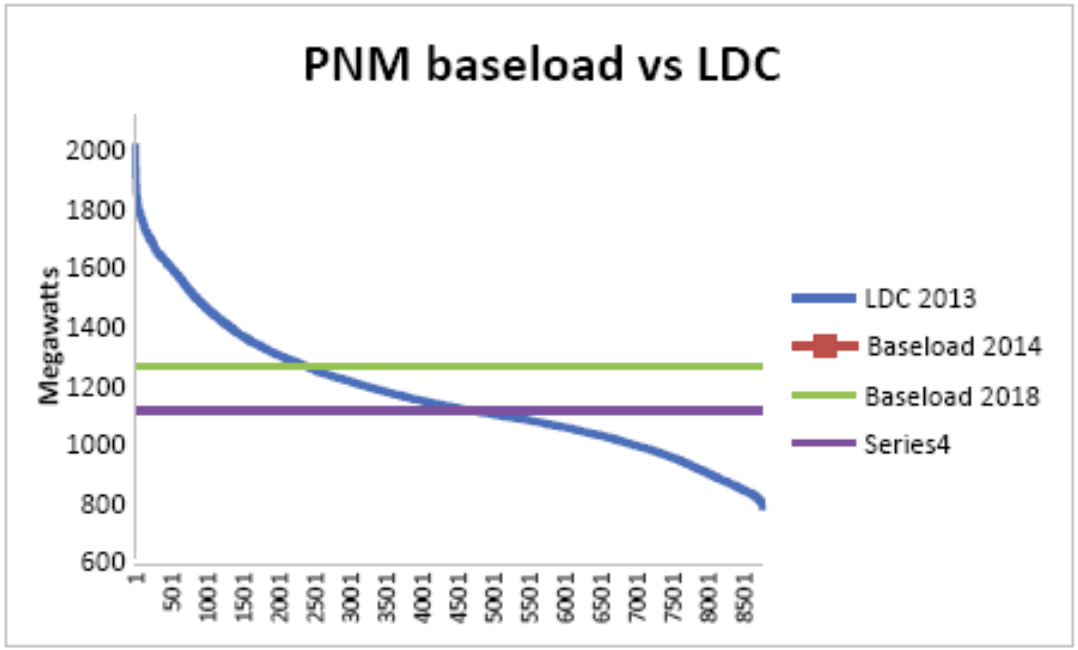


Figure 1 - 2013 Load Duration Curve with Resource Additions

Testimony to NMPRC by DVW, 2015

Q. Does PNM need to replace its lost San Juan unit 2 and 3 capacity with base load?

A. No. PNM has too much base load now and will have too much base load after the retirement of San Juan units 2 and 3 if they add the 132 MW of coal capacity from San Juan unit 4 and the 134 MW of nuclear from PV3. The following chart shows their base load vs their 2013 LDC. With PNM's 2018 base load at 1100 MW, demand is below this amount more than 50% of time.



Annual load profiles for PNM