Electricity market slides
GEOS 24705/ ENST 24705

Electrical grid: Who owns and manages what?

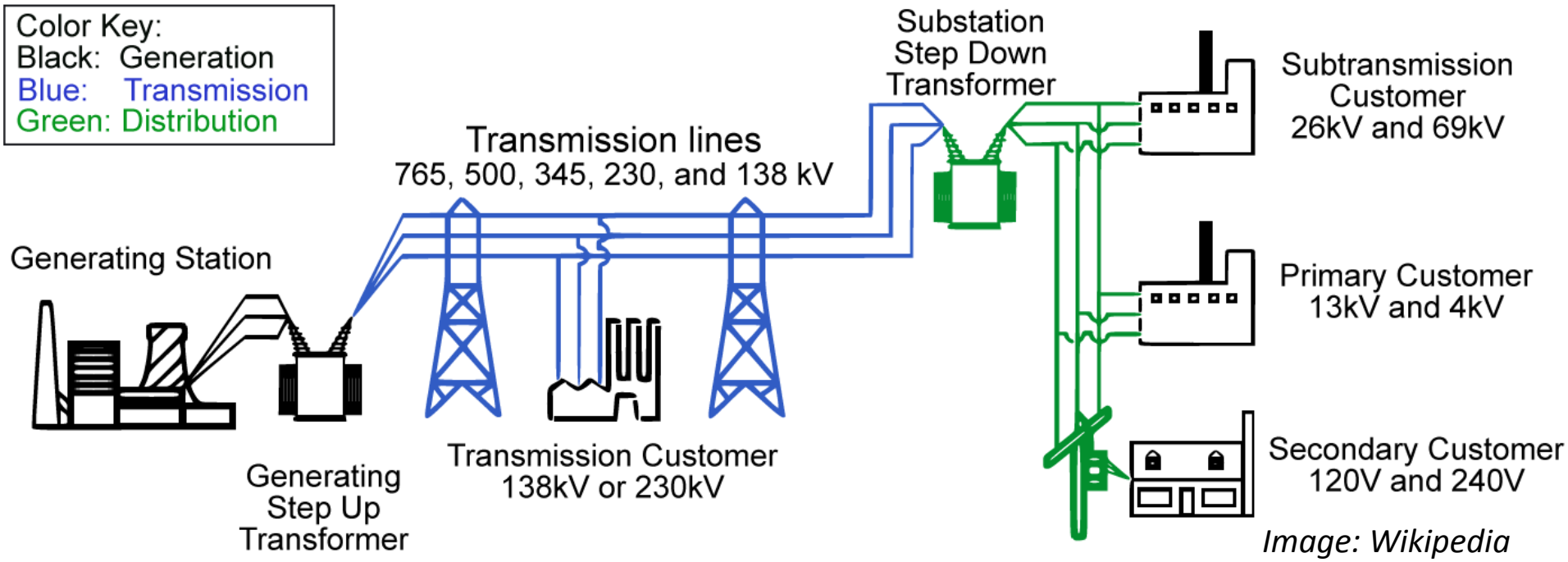


Image: Wikipedia

For most of 20th century, one entity owned all components in chain

Now typically owned by 2 or 3 diff. entities, managed by another, and market can be managed by outside broker – up to 5 players in game

- Generator
- Transmitter (long-dist. wires)
- Grid operator (wires operator)
- Utility for distribution (local wires)
- Load-serving entity (seller to consumer)

Electrical grid: major regulatory shifts

1. UNIFYING AND CENTRALIZING GRID
2. INTRODUCING MARKET FORCES
3. DECENTRALIZING GENERATION

Electrical grid: major regulatory shifts

1. **UNIFYING AND CENTRALIZING GRID: shift from disconnected organizations and transmission to unified transmission** (3 grid regions), gradually more centralized authority

- Federal Power Act (1920, 1935, etc. amended), led to Federal Electricity Regulatory Commission (FERC) in 1977 to regulate rates (+ license hydro)
- Post-1964 blackout – more communication between utilities on voluntary basis to ensure reliability
- Voluntary reliability council (NERC) replaced by "Electric Reliability Organization" with actual enforcement authority in 2005

Electrical grid: major regulatory shifts

2. INTRODUCING MARKET FORCES: Transition from vertically integrated regional monopolies (one utility owns generation, transmission, distribution) to competitive systems

- 1992 Energy Policy Act: FERC can order a company to carry power for someone else
- FERC orders through 1996 encourage formation of Regional Transmission Organizations (RTOs)
- In most places now: utility or load-serving entity buys from multiple independent generators, with a market for power and hourly pricing
- Possibly in the works: proposals for market system on retail side too (req. hourly pricing)
- Still problematic: competitive distribution

Electrical grid: major regulatory shifts

3. DECENTRALIZING GENERATION: Encouragement of distributed power:

- Energy Policy Act of 2005 requires net metering
- Small (2-10 MW) operators can sell at market rate by Federal law
- Demand-side management, or DSM (pay for "negawatt" generation) is now an option in some markets, areas

Electrical grid organization and management: basic questions

- Who owns what? (generation, transmission, distribution)

High-voltage transmission: generally owned by utilities, managed by RTOs (regional transmission organizations), themselves owned by groups of utilities.

Definition: **Regional Transmission Organization**

"An entity that is independent from all generation and power marketing interests and has exclusive responsibility for grid operations, short-term reliability, and transmission service within a region."

Definition: Regional Transmission Organization

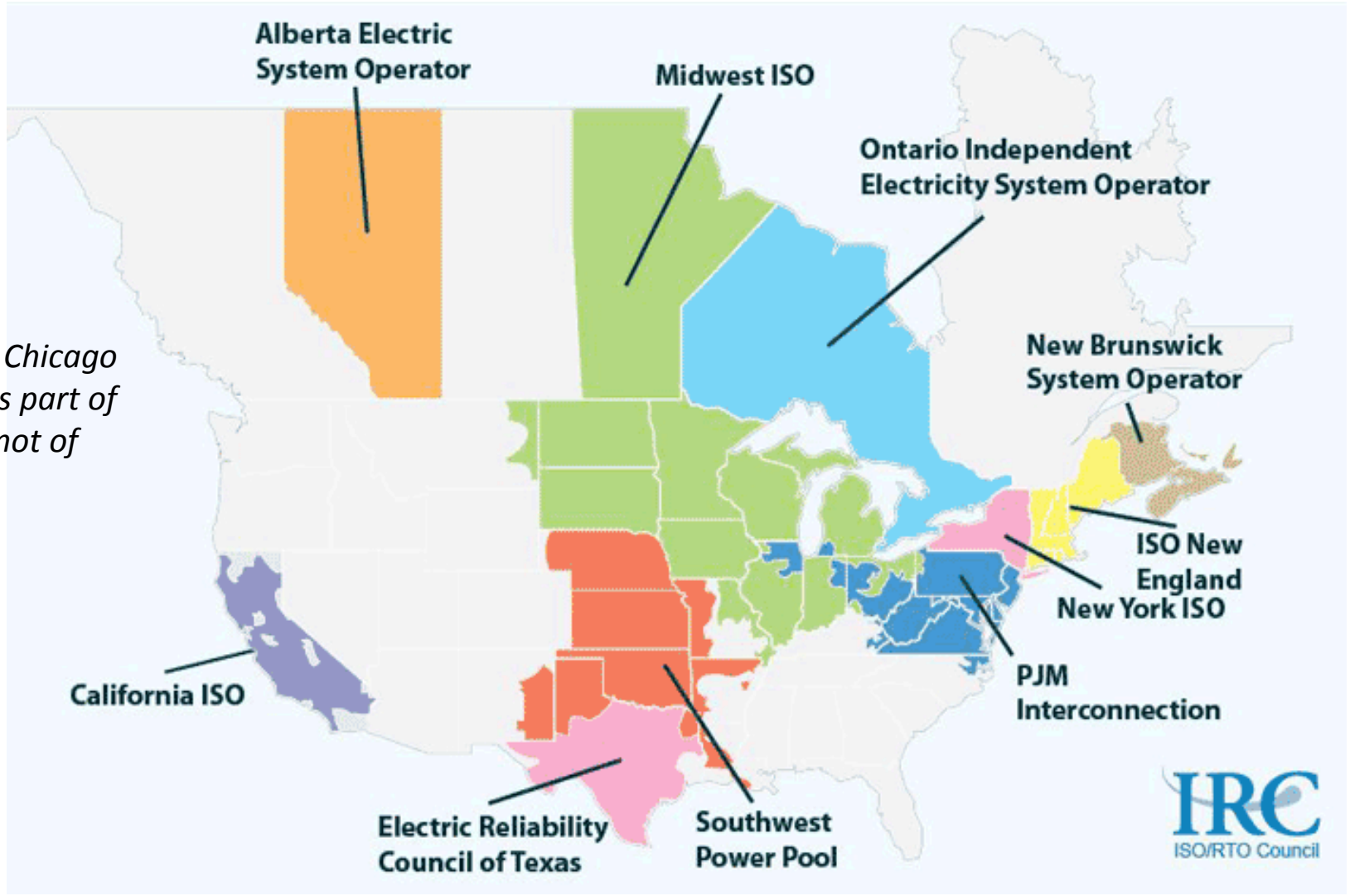
An RTO is an entity created to balance generation across a regional footprint regardless of ownership of generation ….invented to promote competition and hopefully efficiency.

RTOs eliminate the need for generators to contract with separate utilities to sell and transmit power, and prevent integrated utilities to favor their own generation and block transmission of competitors. The goal is to create a transparent market to incentivize more optimal building and dispatching of generation.

Electrical grid organization and management: basic questions

- Who owns what? (generation, transmission, distribution)

RTOs as of 2010 (ISO/RTO Council)



Note: Chicago area is part of PJM, not of MISO

Electrical grid organization and management: basic questions

- Who owns what? (generation, transmission, distribution)

RTO exceptions:

Arizona: from electricity standpoint is essentially a colony of California – its generation not managed by RTO, but independent generators make long-term contracts with California, sell into California markets.

Texas: The only state where a single agency regulates both the generation/transmission side (wholesale prices) and demand side (retail rates). Texas is its own RTO, full state-wide authority. Makes planning much easier to have one central power.

SE U.S. is traditional utility ownership and operation on big scales (e.g. TVA, The Southern Company) so no need for RTOs

Rocky Mtn. corridor doesn't have much transmission

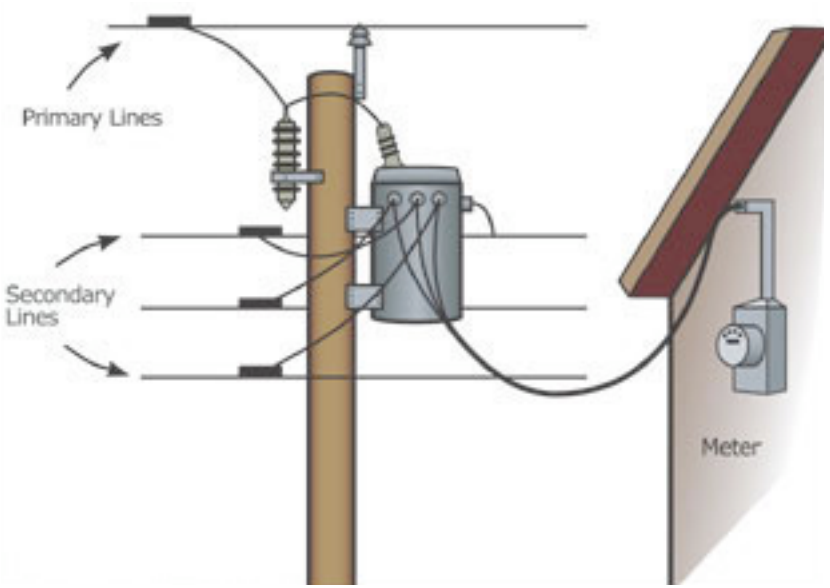
Electrical grid organization and management: basic questions

- Who owns what? (generation, transmission, distribution)

Distribution: owned by utilities: 3170 total in U.S. (75% of customers served by 239 investor-owned; remainder public, co-op, Federal)

The primary job of utilities (like ComEd) is to maintain a distribution network and to sell power to residential, commercial, and industrial customers.

Many utilities still generate much of the power they carry, but some generate none. The businesses of generating and selling are becoming decoupled. You can even bypass the utility for your electricity purchase and ONLY pay them for the distribution service. Very analogous to phone system after deregulation.



Electrical grid organization and management: basic questions

- Who owns what? (generation, transmission, distribution)

Generation: can be owned by utilities but also by independent power producers who sell on the open market

Example: Exelon, who own Dresden nuclear generating station, is not a utility. It is mostly a power company that owns power plants and sells their output to utilities or RTOs.

Exelon *owns* ComEd – the utility is a subsidiary of Exelon, not the other way around. When the lights go out, the guys (or gals) who come fix it will wear ComEd hardhats, not Exelon hardhats.

Electrical grid organization and management: basic questions

- Who owns what? (generation, transmission, distribution)

Summary of ownership

Utilities are "wires" companies. They own the lines, repair the lines, process the billing, take payment from retail customers.

RTOs are managers: (for most people, though not everywhere): manage the market (buy and sell, set clearing prices), exercise minute-by-minute control of generation and congestion management (call to get plants turned on or off)

Anyone can be a generator: in market system power production is open to all

Electrical grid organization and management: basic questions

- 3 markets for electricity generation

For electrical power itself

- Day-ahead market payment made under contract to provide power if needed at market-clearing price
- Real-time market emergency purchases of power as needed minute by minute at pre-set rates

For electrical capacity

- Capacity markets payments made to all generators in RTO simply for existing to provide backup (ca. 2% of elect. price)

Electrical grid organization and management: basic questions

- Who pays, and to who?

RTO: Every day the RTO buys all the power that will be used and sells all that power.

Each day the RTO forecasts power demand for next day. Each day the generators all send in "bids" stating how much they'll be willing to sell their power for. The RTO then buys all the power it thinks will be needed, at the ***marginal price***. I.e. everyone gets the price of the highest-priced seller whose power is bought.

But, the RTO doesn't actually write a check to those generators til the power is used. If power isn't needed after all, no $ change hands. Only if power is generated does the RTO writes a check to generators.

The RTO then turns around and sells all that power to utilities, who then sell it to their customers. The utilities write a check to the RTO.

Electrical grid organization and management: basic questions

- Who pays, and to who?

RTO: Every day the RTO buys all the power that will be used and sells all that power.

Utilities: The utilities pay the RTO.

Utilities can also make "bilateral contracts" with particular generators, to lock in that power for the utility at a given price. If so, the utility then pays the generator just the difference between the market price and the contract price. This is a hedging strategy to minimize risk.

Electrical grid organization and management: basic questions

- Who pays, and to who?

RTO: Every day the RTO buys all the power that will be used and sells all that power.

Utilities: The utilities pay the RTO.

Generators: Sell to RTOs. Also get $ from contracts with utilities.

Generators can also sell directly to customers IF on private land and if the distribution network can be bypassed.

And , generators are also paid not for power but simply for existing, to provide power if necessary. ("Capacity" market)

Electrical grid organization and management: basic questions

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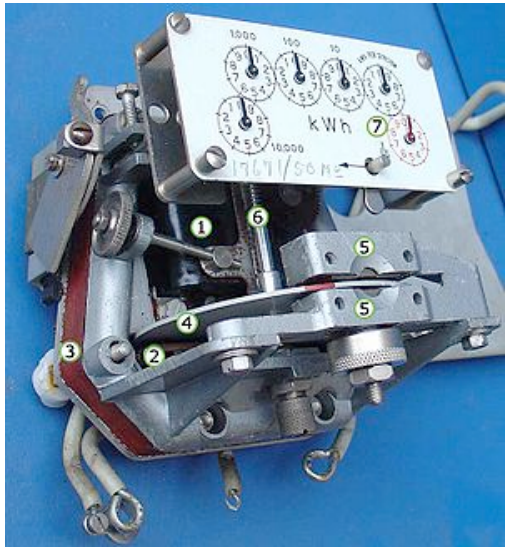
Generators: Sell to RTOs.

Residential power customers: pay $ to the utilities



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Transmission owners: receive payment from the RTO, but just for recovering costs – fixed return on investment. (Need permission to build, though).

Note: If transmission owners are also generators they have insufficient incentive to build more transmission, since get more money for generation if it must be local because of congestion. (Even 15% return w/ no risk from building transmission won't outweigh the profit from generation).

Electrical grid organization and management: basic questions

- Who sets the amounts that people pay?

In the old days

The utilities owned everything, and would charge customers enough to recover their costs. The state utilities commission would approve the rates.

Nowadays

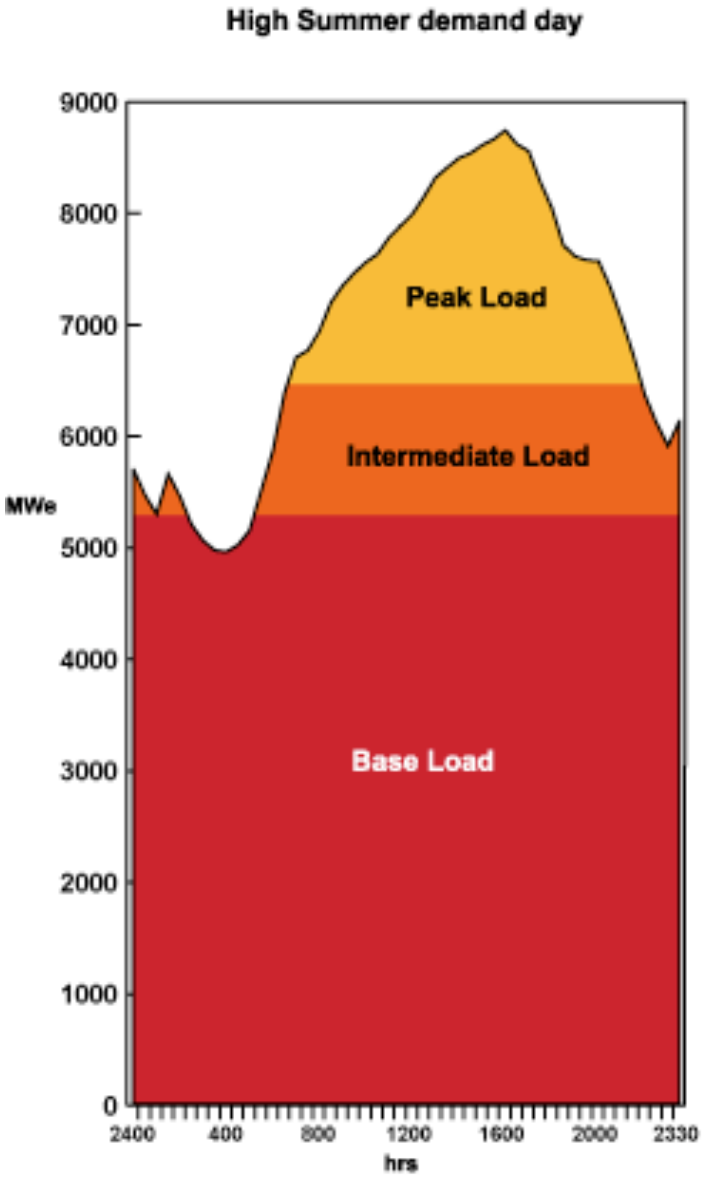
Generator price set by the day-ahead market: Sets the hour by hour price that generators receive for power or for capacity.

Wholesale price set by market and by FERC: Sets the markup that the RTO can charge over market. Sets the transmission rates.

Retail price set by state utilities commissions: Determines the rates that the utilities can charge their customers. Flat rates – no hourly changes.

Usefulness of electricity market driven by

1) diurnal demand curve



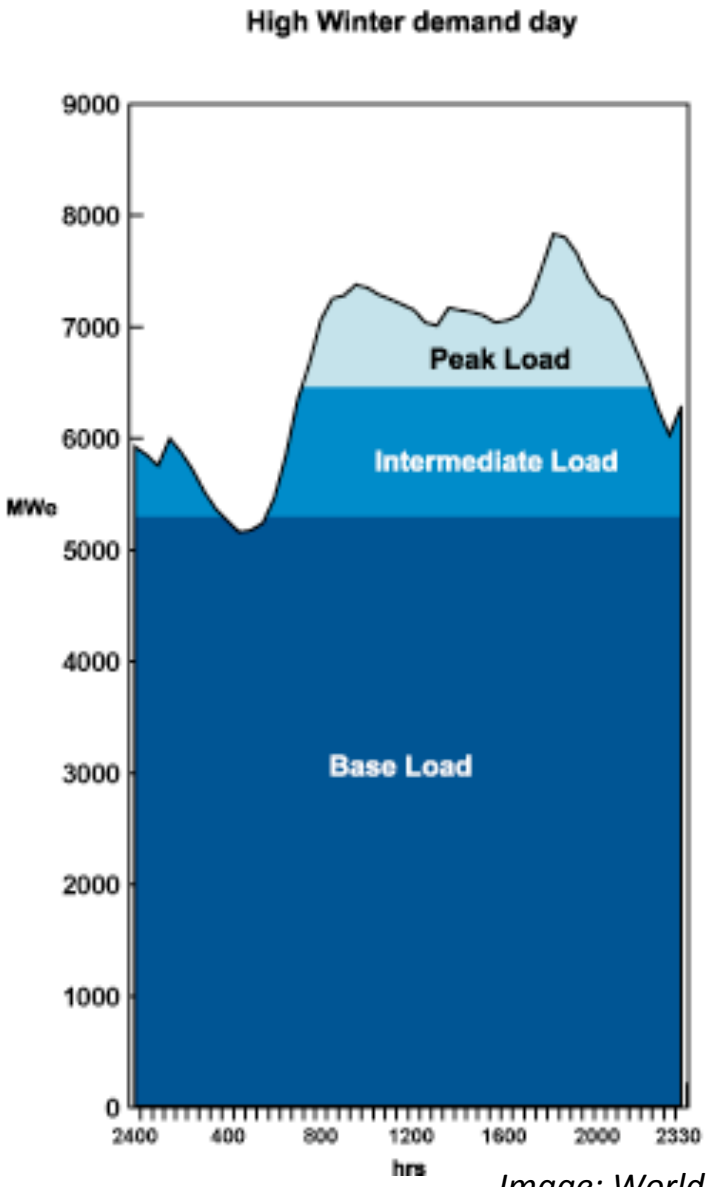


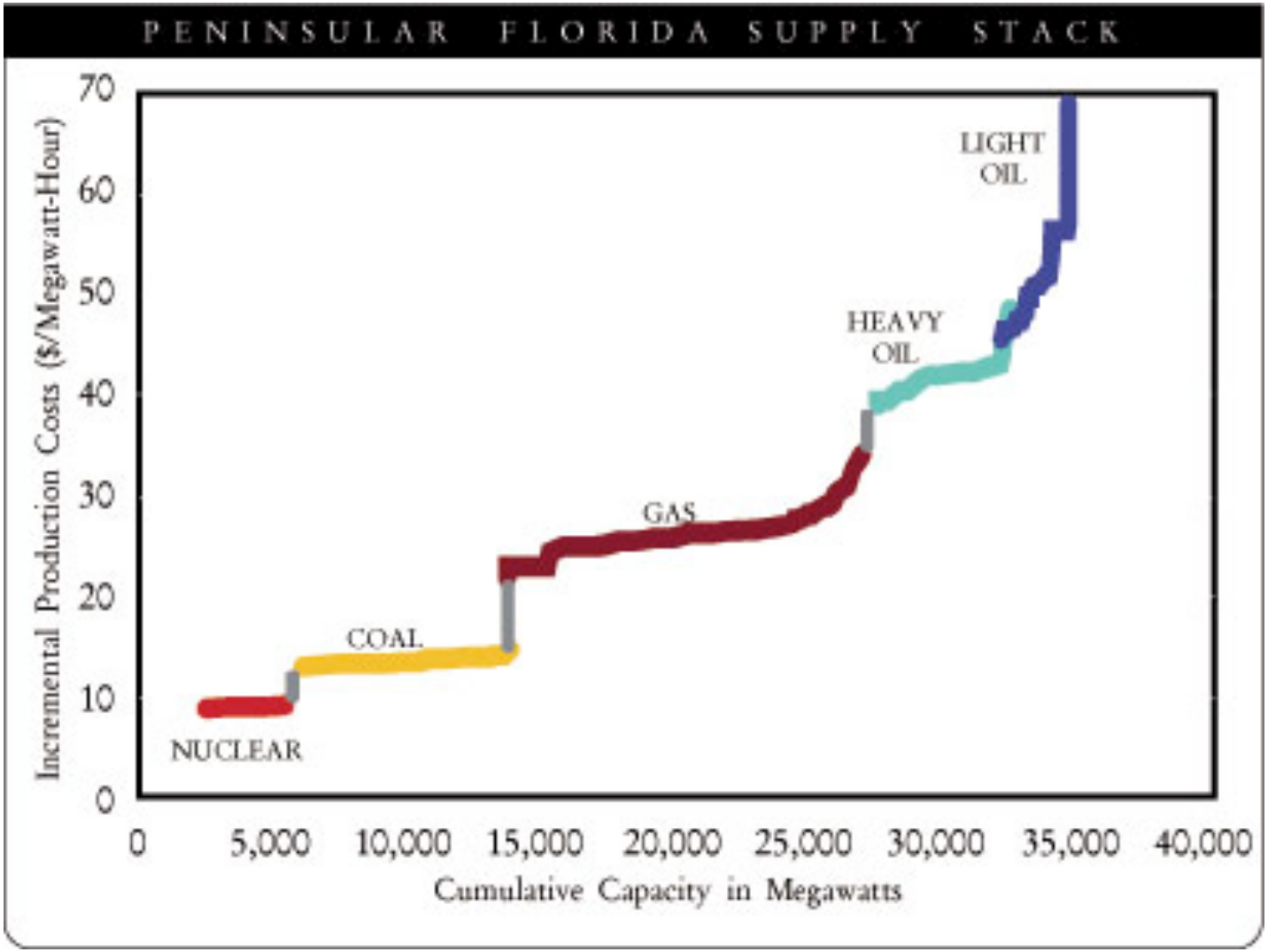
Image: World Nuclear Org.

Usefulness of electricity market driven by

2) different operating cost for different generation technologies

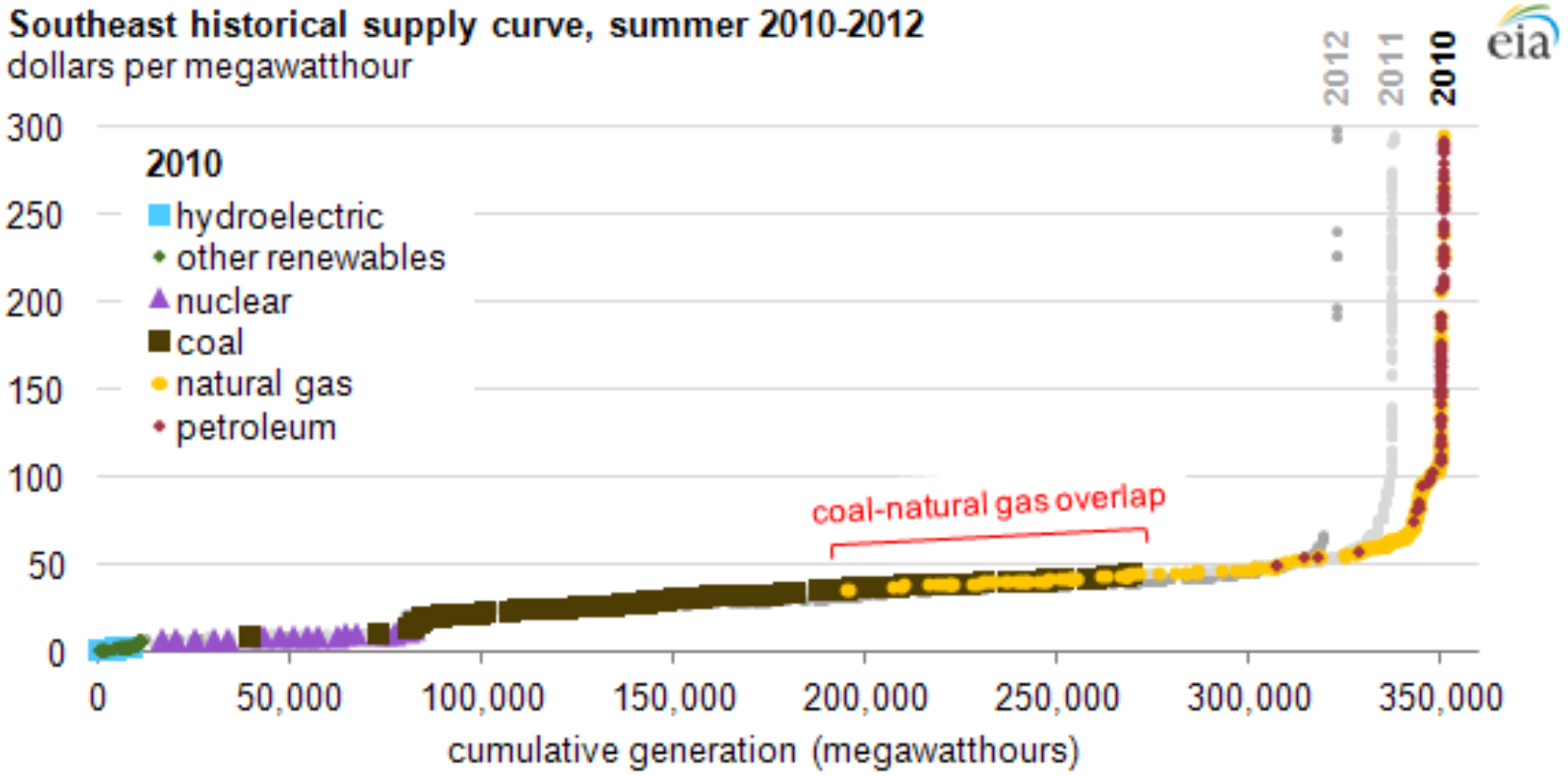
Market clearing means that everyone receives the price bid by the last (most expensive) generator whose bid is accepted. (Hourly bids).

Nuclear will bid zero because it wants to be on always and its operating costs are tiny. Oil is expensive so will bid high – will only turn on if price > operating costs.



Pre-fracking-era supply stack: coal much cheaper than gas

But, supply stack is changing dramatically



- What happens when gas becomes cheaper than non-dispatchable coal?
- What happens when coal plants shut down?
- What happens if utilities contract for wind, or buy no-marginal cost wind?

Peakers vs. baseload:

In all previous history, the expensive marginal cost generation is fast to turn on and off, so can be used as peakers

Generation Type	Response time
Pumped Storage	10 seconds
Gas Turbines	2 minutes
Combined Cycle Gas Turbine	6 hours
Oil Fired	8 hours
Small Coal	12 hours
Large Coal	24 hours
Nuclear	48 hours

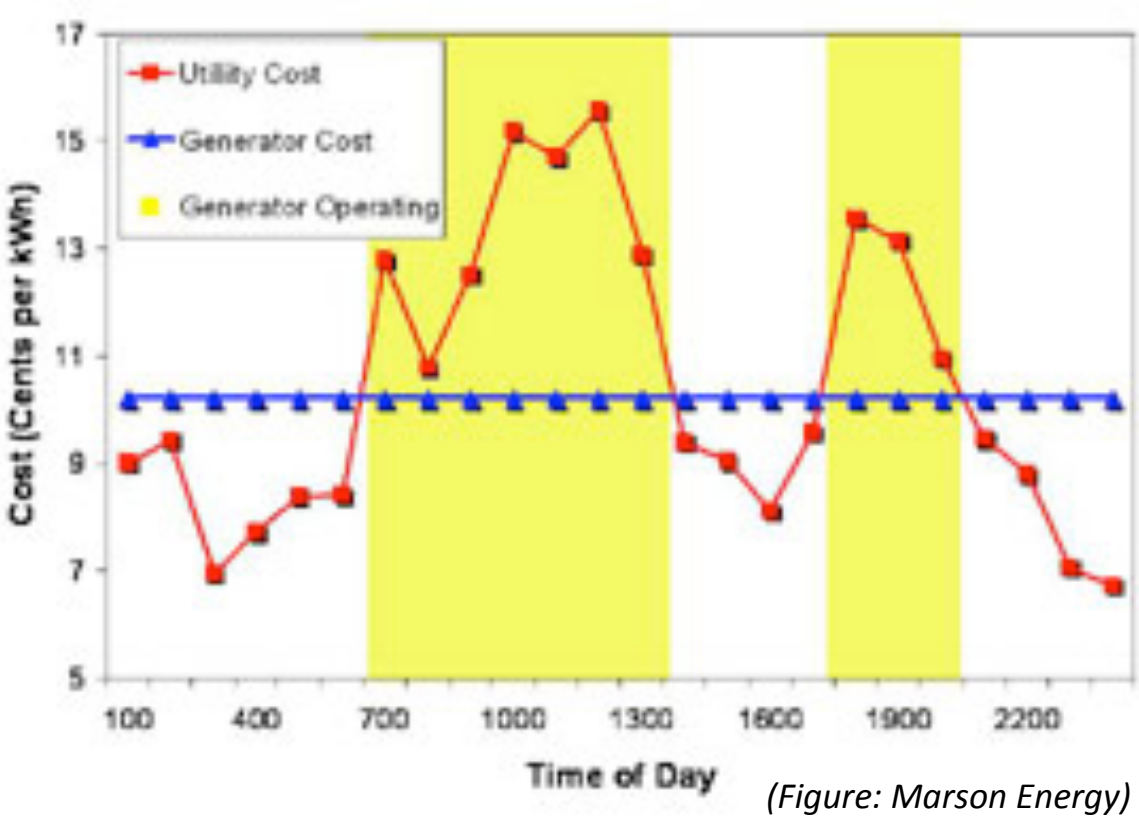
Table 4: Typical Response Times of various forms of Power Generation (National Grid Company, 2007).

Peaker vs. baseload difference fundamental to market

Generators are turned on when their bid is below market-clearing price

Generators bid their marginal costs … then each generator receives the market-clearing price when it is turned on. (Even baseload gets the marginal price.)

Should in theory result in incentives for building more efficient generating capacity, also for clever peak-shaving strategies (demand reduction, storage, etc.)



(Figure: Marson Energy)

Note: the market system does not guarantee that the user will get a lower price than in the old monopoly system. He now pays the **marginal** cost of electricity generation rather than the **average** cost. The marginal cost is always higher than the average cost, but the theory is that eventually retail prices will drop.

Old system: expensive peakers on only during max load

Baseload power stays on all the time. High-marginal-cost power is purchased only during times of day when demand is highest.

But how to manage now if marginal generation is coal, not easily dispatchable?

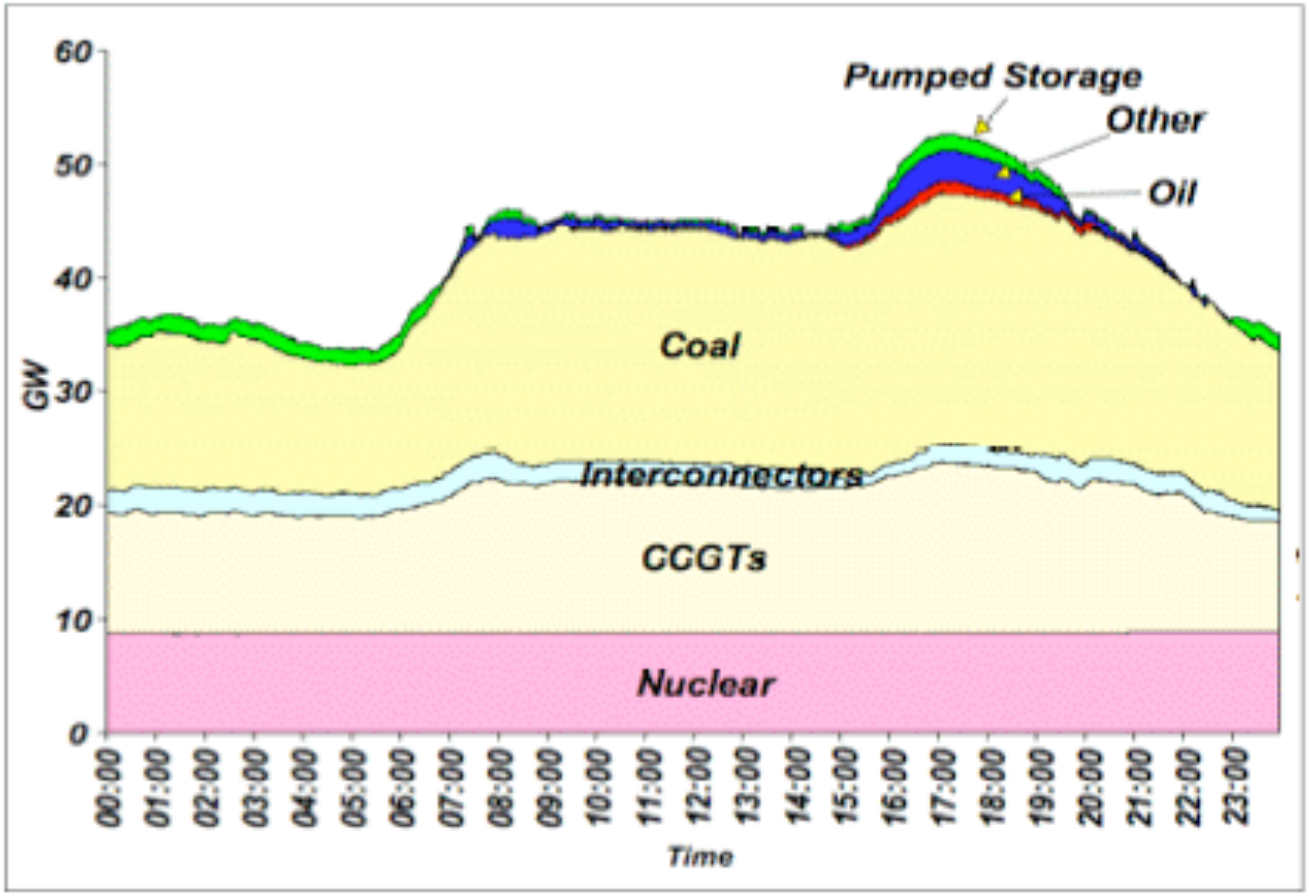


Figure 11: Generation source for a typical daily demand profile. ***Courtesy of NGC 2007***

(CCGT: Combined Cycle Gas Turbines).

(figure from the U.K.?)

Electricity strategies driven by the diurnal cycle

Peakers: buy high cost but fast turn-on generation that can come on just for the peak energy demand period. (*Big complications now that relative costs are flipped.)*

Peak-shaving / storage: buy electricity when it's cheap and store it, then sell it back to the grid when prices are high

Demand-side management: sign contracts with customers forcing them to turn off if demand is too high. Or introduce time-variable pricing for customers to incentivize less use at peak periods, more use off-peak

Load-dumping: some baseload power can't turn off, so just have to dump it if have too much

Curtailment: some renewables can be shut off (e.g. wind)