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What Will the US Modern Grid Cost?

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Technology Laboratory

Cost of Business As Usual?

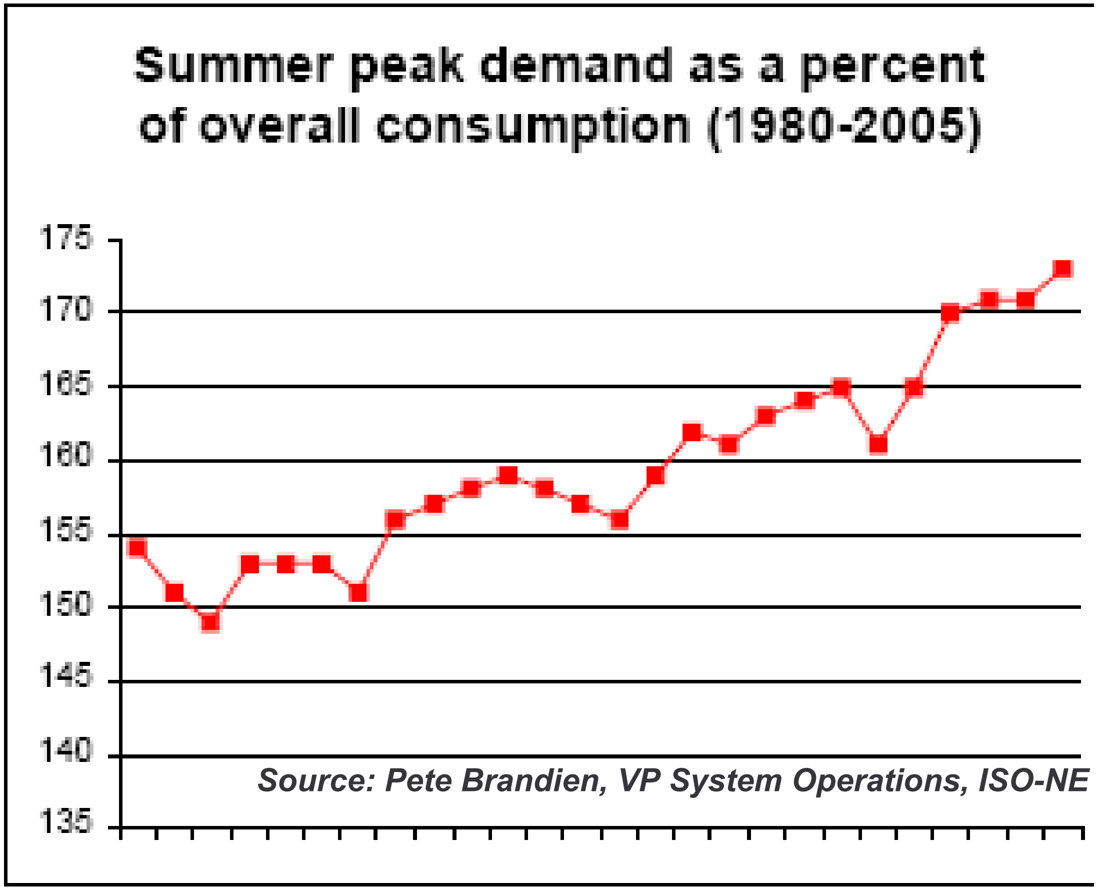
When the lights go out, modern life grinds to a halt. Transportation is interrupted, communications fail, water systems shut down, factory work is disrupted, food spoils, businesses lose money, and people are inconvenienced and even endangered.

– Spencer Abraham, Secretary of Energy, April 2004

Peak Generation Resource Trend

Adding generation to address the peak forces average asset utilization downward.

<u>Peak demand</u>
Avg. demand



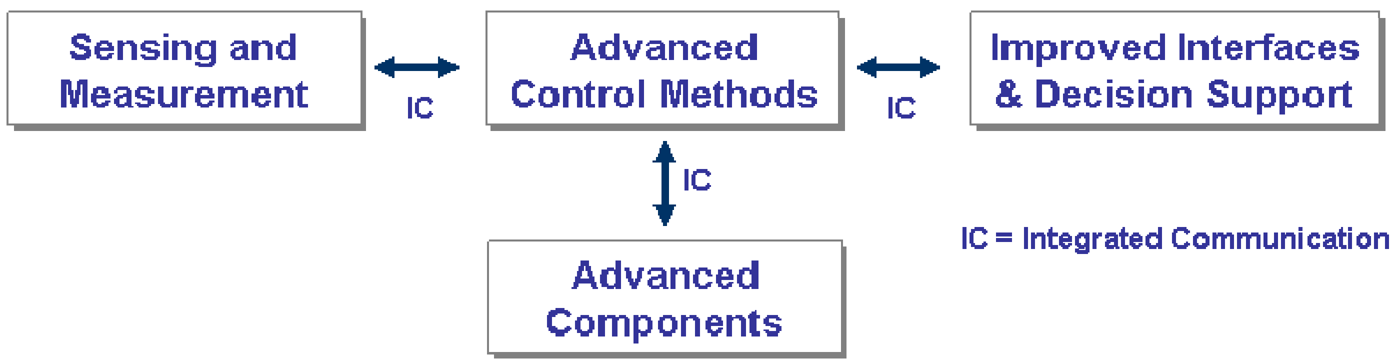
Current Price Tag for Chasing Peak Demand

- **As an industry, we have chased the peak demand with large central-station units, primarily gas fired**
- **Considering the peak to average ratio and the effective cost of generation:**
- **"Real cost" example:**
  - 330 GW capacity in US to just address the peak, majority are gas turbine peakers
  - This is a capital investment of ~$615 billion
  - Now if we consider that these peakers average only 4% utilization in a year, this is an effective ~$15 trillion investment
  - When considering the asset utilization (like manufacturing industry parameters), gas turbine peakers pencil out at $25,000/kw

What is a US Modern Grid?

- it will heal itself.
- it will motivate consumers to be an active grid participant and will include them in grid operations.
- the Modern Grid will resist attack.
- the Modern Grid will provide the level of power quality desired by 21st century users.
- the Modern Grid will accommodate all generation and storage options.
- the Modern Grid will enable markets to flourish.
- the Modern Grid will optimize its assets and operate more efficiently.

Modern Grid: A System of Integrated Technologies



- There are no “silver bullets”; the very act of looking for them costs money
- Analysis showed that significant modernization results from smartly integrating suites of technology that deliver the principal characteristics, which improve grid performance
- So, instead of asking “which technologies,” the MGI team asked “what integration” of technologies will deliver the performance.

Silver Bullets are Expensive

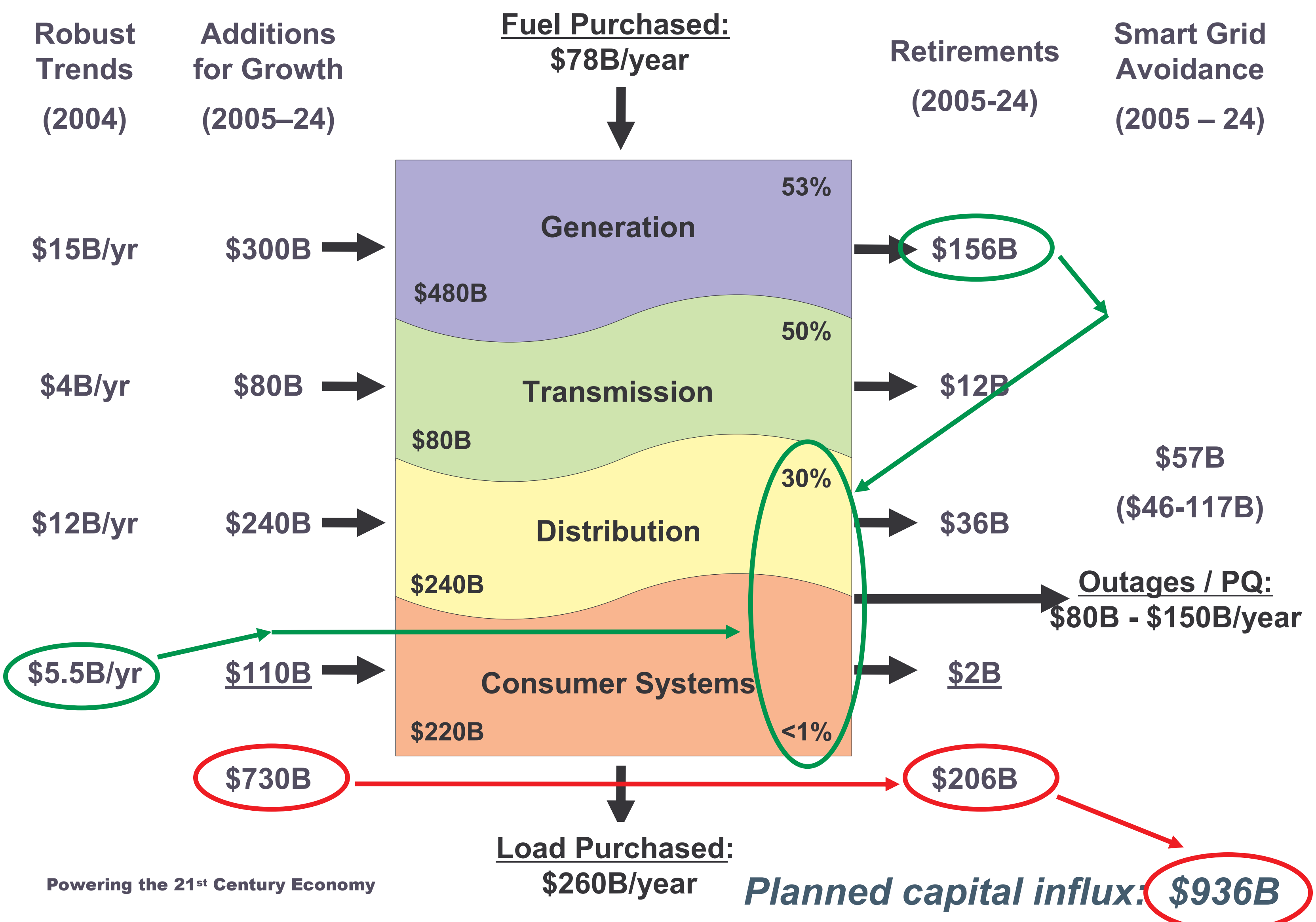
For example, we are not going to do a wholesale replacement of all our aged high voltage transformers on the grid over the next few years at a price tag of $300Billion.

So, we must find ways to improve grid performance through integrating "new" technologies with these "old" technologies.

McAdams Second Theorem:

Nothing is impossible which is currently taking place.

The Financial Electric System



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What Have We Learned from Others?

Modernizing the Grid with Smarts

- **Key learnings from four smart grid studies**
  - Significant ability to address peak demand with relatively small penetration of dispatchable DG (5% to 10%) at one-fourth the cost of using peakers
  - If you are focused on reliability drivers only, a DER / smart grid focused strategy costs ~ +6% more than the “business as usual” Capital Budget Plan (5-yr or 10-yr plan)
  - If you are focused on significantly improving renewables penetration while maintaining reliability, a DER / smart grid focused strategy costs as much as -20% less than the “business as usual” Capital Budget Plan
- **Wind power support example**
- **Denmark example**

Wind Power and the Grid

- **Interesting insights**
  - There seems to be better penetration when distributed
  - Intermittency is a serious challenge to grid stability
  - Non-traditional options (storage, CHP) seem to be better partners in wind power than traditional options (CTs)
- **Meaningful intermittent renewable resource penetration (wind and solar) on the grid is directly tied to the sophistication of grid control**
  - “Distributed, integrated” design
  - The wave is happening at the “edge” – can spill over into grid issues if not prepared

Wind Penetration – Grid Limitations (Example)

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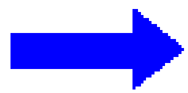
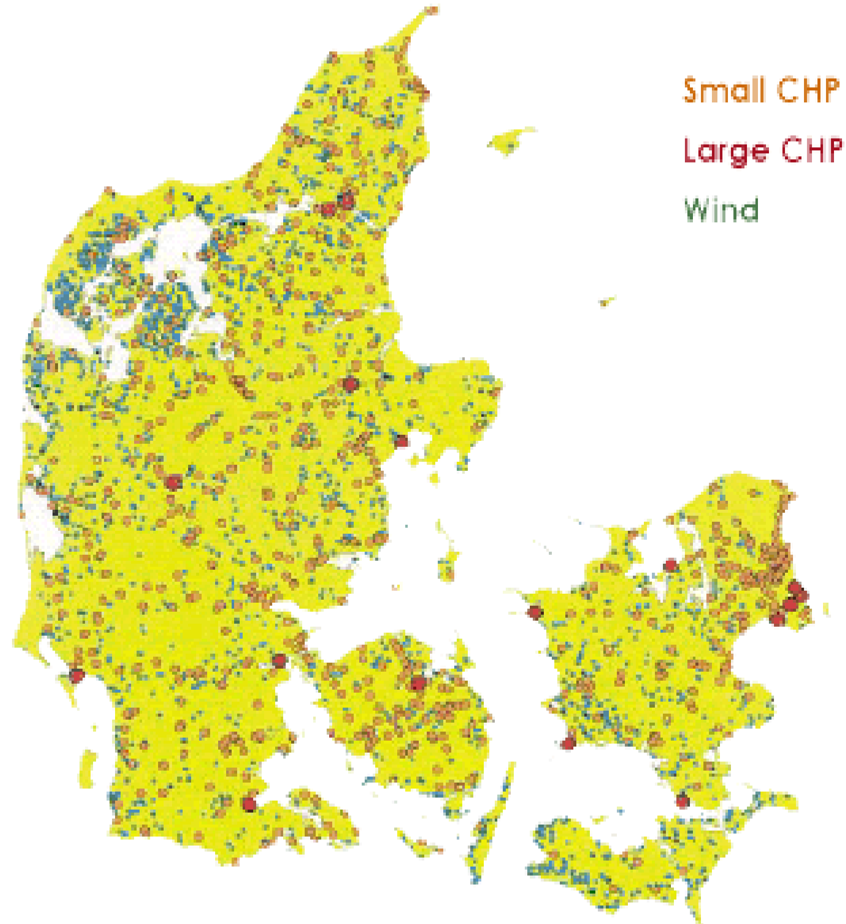
Region	Wind Penetration When Instabilities Identified / Experienced	Source
WECC / BPA	6%	Analysis
WECC / CAISO	3%	Analysis
Germany	12%	Actual
Austria	12%	Actual
Spain	13%	Actual
Denmark	32%	Actual

Denmark Changed in Two Decades

Centralized System of the mid 1980's



More Decentralized System of Today



Source: Danish Energy Center

Making the Business Case

System Benefits	Societal Benefits
Reduced congestion cost	
Reduced restoration time and reduced operations and management cost due to predictive analytics, self-diagnosing and self-healing	Fewer blackouts Fewer unplanned outages and interruptions
Reduced peak demand	
Increased integration of distributed generation and higher capacity utilization	[measurable societal benefits too]
[measurable system benefits too]	Power quality, reliability, and system availability and capacity improvement due to improved power flow
Increased security and tolerance to attacks and natural disasters	
Increased capital investment efficiency due to tighter design limits and optimized assets	[measurable societal benefits too]
Environmental benefits through increased asset utilization	[measurable societal benefits too]
Tax benefits from asset depreciation, tax credits, and other incentives	

Conclusions

- **So, what will a Modern Grid cost?**
  - Probably less than the “Business As Usual” case.
  - +6% to -20%
- **There has to be set of industry drivers that encourage investment and action in modernization of the grid.**
  - Policy and regulatory change at the state level
  - Courage in the industry to try a non-traditional approach
  - It has been done before
- **One size does not fit all**
  - Regional (physical) variables must be considered

Unique Regions (Summary of MGI Summit Feedback)

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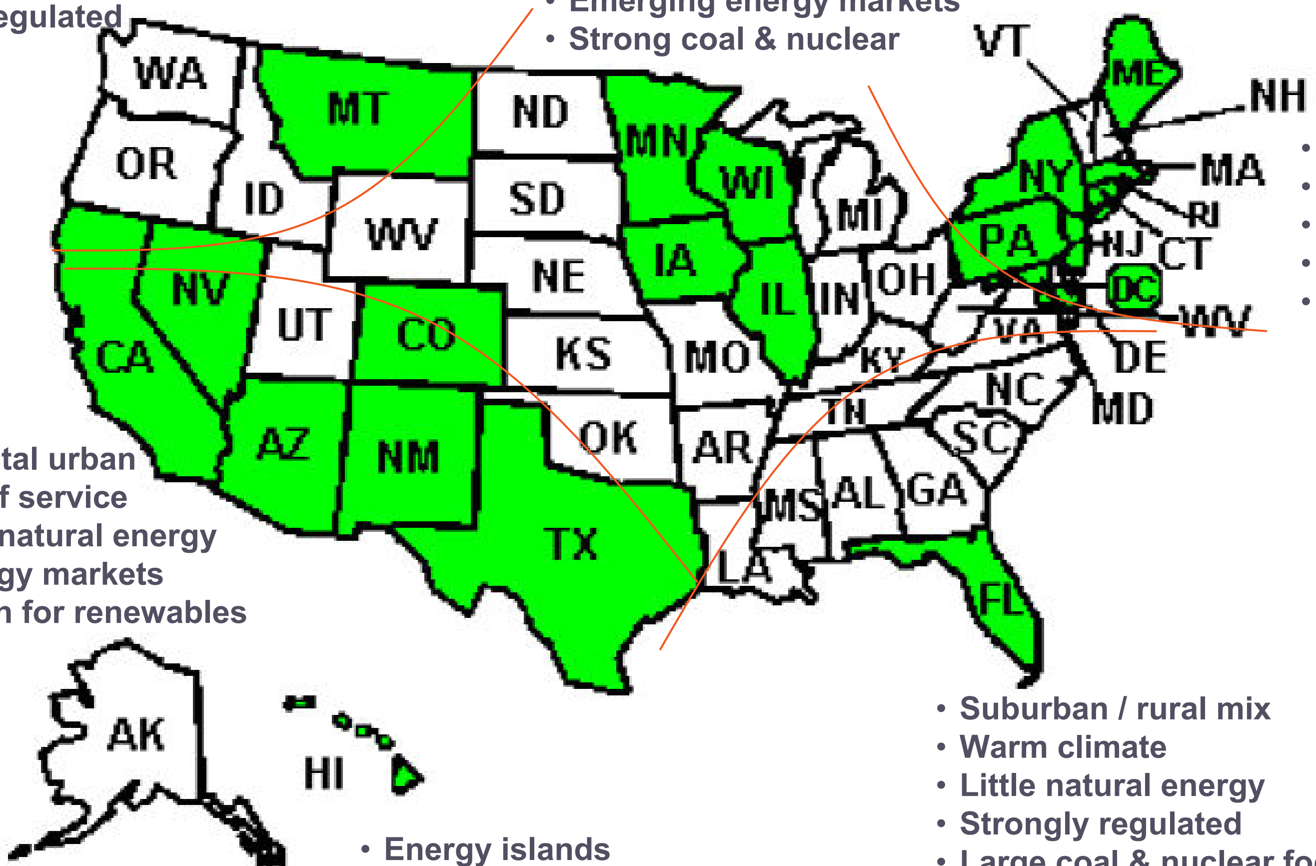
- Suburban / rural mix
- Much natural energy
- Growing green energy policy
- Large hydro resources
- Strongly regulated

- Vast rural regions
- Heavy industry
- Good wind resource
- Emerging biofuel focus
- Emerging energy markets
- Strong coal & nuclear



- Dense urban
- Heavy commercial
- Little natural energy
- Active energy markets
- High cost of service

- Dense coastal urban
- High cost of service
- Significant natural energy
- Active energy markets
- Strong push for renewables

- Energy islands
- Much natural energy
- Strongly regulated

- Suburban / rural mix
- Warm climate
- Little natural energy
- Strongly regulated
- Large coal & nuclear focus

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