Smart Grid & System Planning

Power System Planning & Implementation Committee
Pittsburgh, PA
July 23, 2008

Agenda

- Introduction of attendees & signup
- Approval of GM2007 Meeting Minutes
- Committee officers re-alignment
- Technical Council & Editorial Board matters
- Some selected issues
  - Smart Grid
  - Carbon Footprint
  - Test Systems for Smart Grid
- Issues for the industry
  - Energy Supply WG (Jian Yang)
  - Transmission WG (Paola Bresesti)
  - Distribution WG (Bob Fletcher)
  - Customer Service WG (Hahn Tram)
  - Asset Management WG (Dave Egan)
- Develop programs for
  - PSCE at Seattle, March 15-18, 2009
  - GM2009 at Calgary, July 26-30, 2009
  - T&D Expo at New Orleans, April 19-22, 2010
- Adjourn

Revised after GM2008

PSPI Committee

ML Chan, Chair

Liaison to PSCE Comm. – Anil Pahwa

Vice Chair/TCPC

Anil Pahwa

Secretary

Veronika Rabl (pending)

Liaison to Technical Committee Advisory Board Member – Lina Bertling

Liaison to Wind Power Coord. Comm. – Zhao Xu

Liaison to Emerging Technologies Coord. Comm – Fran Li

Liaison to Intelligent Grid Coordinating Comm. – Fran Li

Liaison to Energy Policy Development Coord. Comm. – Anil Pahwa (New one?)

Energy Supply WG

Jian Yang

Transmission System WG

Paola Bresesti (pending)

Distribution System WG

Bob Fletcher

Customer Services WG

Hahn Tram

Asset Mgmt. WG

Dave Egan

Organization Alignment

- New Vice Chair and TCPC – Anil Pahwa to replace Richard Brown
- Energy Policy Development Coordinating Committee – with Anil Pahwa being the Vice Chair, will need a replacement for him on this liaison; still pending
- Secretary – Kevin Jones to consider
- Web support for Committee – will approach Secretary to do that; more of content management because IEEE has a webmaster with standard templates for Committee websites

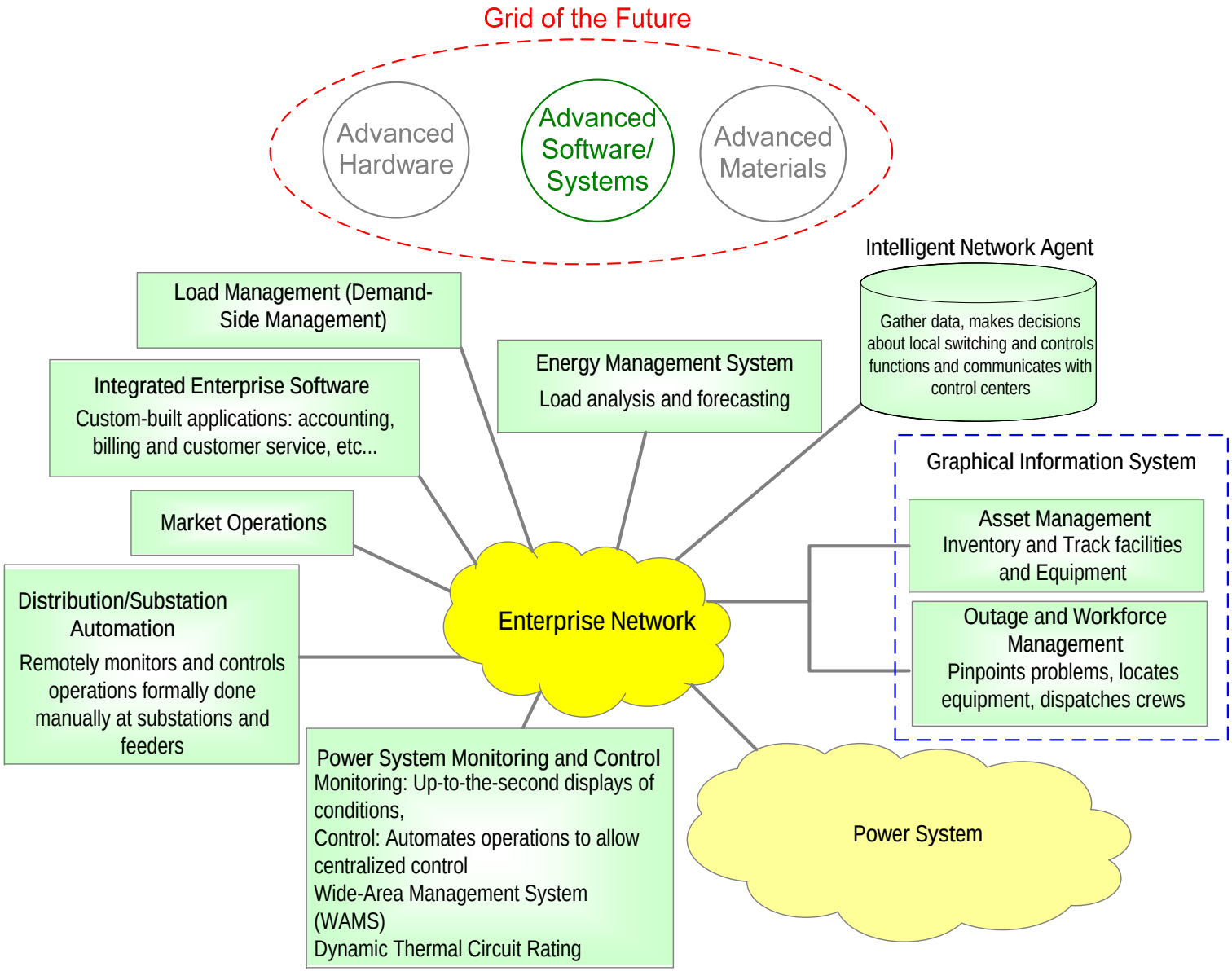
Technical Council Matters

- Get Combo sessions for each Committee and WG
- Joint Committee Working Meeting at Southeast
- Smart Grid Coordinating Committee
- Standards need to work with IEC for Dual Logo
- T&D Show at Spring; GM in late July; PSCE in early Spring

Editorial Board Meeting

- TPWRS has about 37% acceptance rate with over 1200 papers a year to be reviewed
- Achieves >90% for completed review within 2 months or so
- New Manuscript Central v4 ready

Smart Grid


Grid of the Future
Advanced Hardware
Advanced Software/ Systems
Advanced Materials
Intelligent Network Agent
Gather data, makes decisions about local switching and controls functions and communicates with control centers
Load Management (Demand-Side Management)
Energy Management System
Load analysis and forecasting
Integrated Enterprise Software
Custom-built applications: accounting, billing and customer service, etc...
Graphical Information System
Asset Management
Inventory and Track facilities and Equipment
Market Operations
Outage and Workforce Management
Pinpoints problems, locates equipment, dispatches crews
Distribution/Substation Automation
Remotely monitors and controls operations formally done manually at substations and feeders
Enterprise Network
Power System Monitoring and Control
Monitoring: Up-to-the-second displays of conditions,
Control: Automates operations to allow centralized control
Wide-Area Management System (WAMS)
Dynamic Thermal Circuit Rating
Power System

Smart Grid Test Distribution System

- Laboratory test system to evaluate impacts of SG applications
- Standard evaluation system
- CIGRE has developed such systems
- Need to work with Rick Roberts and also Distribution Feeder TF (Tom McDermmot)

Should it be our project? Yes, Distribution WG will work with Tom McDermott and Lina Bertling. Perhaps the WG should adopt the CIGRE's work by Prof. Kai Strunz and define the requirements of such a Test Smart Grid System. The Distribution WG will pass the info to Lina since she is also chairing another Task Force in another Committee on test feeders. A sample list of requirements for such a test system is in Appendix A – the Distribution WG talking point slide deck.

Carbon Footprint

- Carbon trading involving refurnishing deforestation; global trade of carbon rights; not just best control technologies
- Every utility operation should have carbon footprint implications
- SG integrates renewable, PHEV, DG and DR; closer to load; system efficiency being promoted

We reviewed a presentation by Veronika Rabl on estimating the cost of carbon footprint reduction. The presentation is attached in Appendix B below.

Programs Decided

- Energy Supply WG will deliver a tutorial “How to do basic supply and generation planning under Smart Grid?”. A full day session, with the first half being theory-focus, and the second focusing on case studies involving Smart Grid, Demand Response and Wind Integration. Planned for GM2009.
- Distribution WG will deliver ½ day panel session entitled “Smart Distribution Planning for Smart Grid”. Several WG members have agreed to be on the panel. For GM2009.
- Asset Management WG will deliver a WG paper in a combo meeting presenting PAS 55, and has also indentified some important issues: (For GM2009)
  - NERC compliance standards
  - Regulatory agencies determine how utilities spend money on AM
  - Need to move towards risk-based maintenance
- AM WG also considering an enterprise IT system paper for AM, to be coordinated by Charles Ensendal for GM2009.

Programs decided in GM2008

WG	PSCE, Seattle, March, 2009	GM2009, Calgary, July, 2009	T&D Show, New Orleans, April 2010
Energy Supply		Full day (Mike Henderson) Tutorial:"How to conduct system planning with SG"; includes updates of DR, JCSP, Smart Grid, Wind with case studies in the afternoon	
Distribution WG		Panel Session: Smart Plan for Smart Grid (Bob Fletcher)	
Asset Management WG		panel session on PAS 55 (Dave Egan) SG & Enterprise IT System (Charles Ensandal)	
Transmission WG	Transmission Planning integrated with Wind Generation (Ali Chowdhury)		
Customer Service WG			

Translated into Requirements

- More visibility to the distribution system
  - IEDs, AMI meters, “inexpensive” PMUs
  - State estimators
- More local intelligence control of the system
  - Communications infrastructure (e.g., PTP)
  - Ability to communicate/interoperate devices
- Condition-based maintenance
- Optimal utilization of infrastructure capacity
- DGs, storage & renewable forming micro-grids
- PHEVs; interface with Home Area Networks (HAN)
- PQ concern

What is Smart Grid?

- Smart Grid is a vision for electric utilities: Utilities, and consumers will accrue values through the convergence of power delivery and information technologies to achieve improved reliability, reduced O&M costs, avoidance of new capacity, and increased customer satisfaction.
- Applied to G, T, D and customer sectors by leveraging computer and communications infrastructure and technologies
- SG is not a set pf shrink-wrapped solutions; the set and scope are unique to each utility, in the context of traditional capacity engineering and planning

Smart Grid at Generation System

- Real-time heat rate calculation modules
- Continuous emission monitoring systems
- Continuous asset condition monitoring systems for CBM
- Integration of intermittent renewable resources with energy storage technologies

Smart Grid at Transmission Systems

- PMUs to provide time synchronized data on system dynamics
- Wide Area Protection System (WAPS) for improved system reliability
- FACTS to optimize the utilization of capacity
- Substation automation involving IEDs for protection and condition monitoring
- Closer integration in planning with distribution system planning

Smart Grid at Distribution Systems

- Feeder Automation
- Fuse Clearing via fast curves
- Remote monitoring of FCIs
- Real-time incipient fault prediction
- Integrated volt/var control
- Feeder & Sub Peak Load Management
- Equipment Condition Monitoring
- Distribution SCADA or DMS

Smart Grid at Distribution Systems (cont'd)

- Substation Automation
  - Data concentrators
  - Use of IEDs and Data Concentrators
  - Equipment Condition Monitoring with non-operational data
- Micro-grid management involving DGs, Renewable and PHEVs

Smart Grid at Customers

- AMI System
  - AMR
  - Outage detection
  - Remote Service Connect/Disconnects
  - Integrate DR resources (e.g., smart thermostats)
- Customer Portal Systems for energy management

Minutes from the Last GM2007 Meeting

(To remind Committee members as to what we have decided
in GM2007 at Tampa, Florida)

Sessions Planned

WG (Chair)	T&D Show, Chicago, 4/21-24/08	GM2008, Pittsburg, 7/20/2008	PSCE, Seattle, March 2009
Energy Supply (Jian Yang)		Panel/Combo Session (organized by Mike Henderson) on "Smart Grid and Resource Planning for Economics & Environmental Adequacy"; panelists include different stakeholders such as ISO/FERC, Developers, Envrionmentalists, Utility and Load.	
Transmission (Paola Bresesti)		Panel/Combo Session (organized by Siri Varadan) on "Smart Grid and Integrated G&T Planning Tools"	Panel Session (organized by Mike Henderson) on "WAPS and Inter-area Planning"
Distribution (Robert Fletcher)	Panel Session (organized by Fran Li, with assistance by Ravi Seethapathy) on "Smart Grid and Best Practices in Distribution Planning"	Panel/Combo Session (organized by Bob Fletcher) on "Smart Grid and Distribution Planning"	
Customer Services (Hahn Tram)		Panel/Combo Session (organized by Hahn Tram or designate) on "Large Scale Deployment of AMI Systems - AMR as the Initial Phase"	
Asset Management (Dave Egan)		Panel/Combo Session on "Smart Grid and the Inner Workings of Asset Management - Data for AM, Methodologies for Planning & Budgeting, and Disciplines of AM (organized by Dave Egan)	Paper Session - Standard Terminology for AM (WG paper). Panel session (organized by Zoilo Roldan) on "Aging and Lifecycle of Assets"

Asset Management WG Perspectives

- Three major issues for AM
  - Data needed for AM
  - Methodology for budgeting and planning
  - Disciplines required by AM
- Standard terminologies for AM to be developed
- How does AMI enable AM
  - Communications media afforded by AMI
  - Requires data mining engines
  - What is “asset”? Power delivery asset and information asset?
    - Communications equipment
    - T&D equipment
    - Controllers

Asset Management WG Perspectives (cont'd)

- Aging asset and lifecycle perspective for asset
- Root-cause analyses of asset failures
- Smart Grid and the enterprise IT to make it happen
- Resource requirements to implement AM initiatives

Distribution System Planning WG Perspectives

- Distribution system planning in the context of Smart Grid requires “smart planning” – how to expand “smartly”
- What does the future distribution infrastructure look like? Sensor, controllers and processors proliferation; from data to information to control actions
- What are the new “loads”? DGs, DRs, renewable...
- Need for small area load forecasts that can capture DGs, DRs, etc.

Distribution System Planning WG Perspectives (cont'd)

- Major issues for incorporating Smart Grid
  - Modeling and simulation tools (e.g., wind generators models that capture governor controls)
  - Planning guidelines and standards
  - Push for greater efficiency (e.g., reduce losses)
  - More push for real-time analyses and planning
  - MV and LV to be considered as one system for planning

Transmission Planning WG Perspective

- Siri Varadan presented a methodology for risk assessment in transmission planning in BPA (Appendix 3). It points out a methodology for capturing risks in planning under Smart Grid.
- Paola Bresesti, Chair of Transmission WG, prepared a set of transmission planning issues under Smart Grid (Appendix 4) though she could not make the conference. That provided platform for discussion of issues below.
- Risk and uncertainties come in different forms – “size of the energy resource lumps”, how controllable/curtailable/dispatchable are the supply resources; how to quantify risks?

Transmission Planning WG Perspective (cont'd)

- Education of the public is an integral element of transmission planning
- Need for an "Integrated G&T Planning Tool", a TEAM approach; in Canadian market, <10 MW DGs are not on the radar screen, but they should be.
- How to quantify the benefits
  - Competition (e.g., market power impacts)
  - Reliability
  - Sustainability (Is that as simple as CO_2 reduction or should it be a holistic environmental approach? Or should energy efficiency adopt an elemental approach – starting from the transformation of the original chemical elements to kWh?)

Transmission Planning WG Perspective (cont'd)

- How to model the "load", which is a resource, especially when DGs and renewable are present
- Impacts of Smart technologies (work with T&D Committee's WG1505)
  - PMUs
  - Wide Area Protection Systems
  - FACTS

Energy Supply WG Perspectives

- Resource Adequacy is a major issue
  - Economics vs Reliability vs Environment
  - Site selection (optimization of multiple resource concerns – water, gas, transmission) and Total Energy Planning, not just electric planning
  - Free ridership issue in transmission upgrades
  - Interconnection queue vs inequity
  - Coal/IGCC/GHG vs CO_2
  - Nuclear – permits and cost issues
  - Wind – intermittency a concern to system dispatch
  - Solar – cost
  - Gas (CCGT)
  - Blackstart, AGC, Reactive Power and SR

Energy Supply WG Perspectives (cont'd)

- Another major issue relates to the Market
  - Market design & impacts (e.g., LMP vs zonal, DA market, capacity market); need to encourage DG and renewable proliferation
  - Emission market
  - Deregulation vs Re-regulation
  - Bidding strategy
  - Merchant vs contracts

Energy Supply WG Perspectives (cont'd)

- Another major set of issues relates to DGs & DRs
  - Emergency generators needed for blackstarts if to be truly "self healing" grid
  - Island and micro-grid operations
  - Size of units
  - Degree of dispatchability for DGs
  - DR as a viable resource; may need to remove rate freeze for DR to be truly viable; policy issue with AMI system investment
  - Fuel cells; could be a mobile load

Appendix A

Appendix B

Appendix A
Planning for Smart Grids

Robert H. Fletcher, PhD, P.E.

Principal Electrical Planning Engineer
Snohomish Public Utility District
Snohomish County
Everett, WA

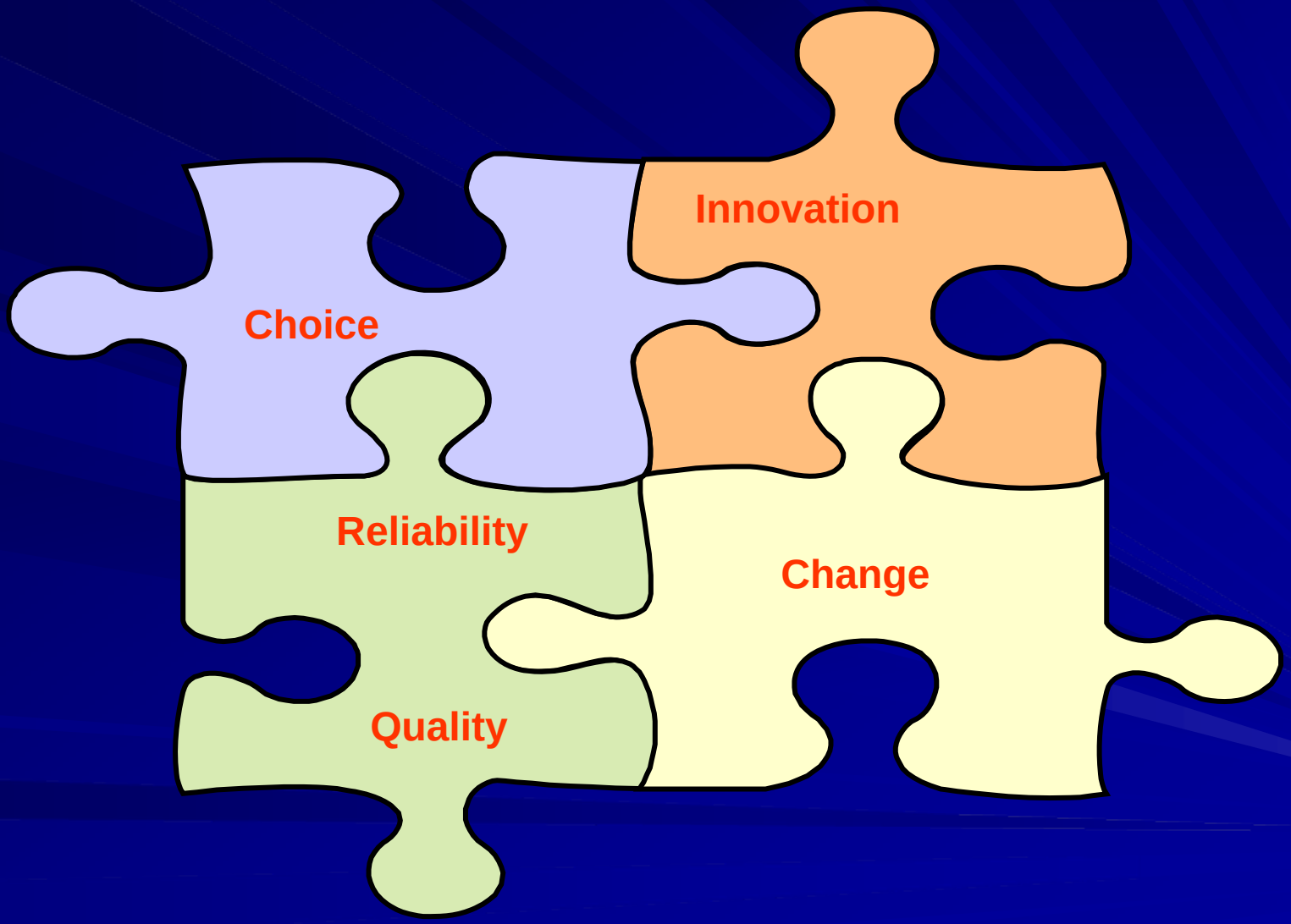
July 23, 2008

Overview

- What is the Smart Grid Vision
- What is role of Distribution Planning
- Why are Smart Grids needed
- What will the Smart Grid look like
- What new distribution Planning tools are needed

The Distribution System

A Vision of the T&D Future



Smart Grids will Support and Enable:

Sustainable Energy Development

- Accessibility of a wide variety of renewable resources and demand responses
- Distribution system and customer flexibility
- Enhanced reliability, power quality, and system self healing
- New technology value added products and services that empowers the customer
- Economic best value through innovation and efficient energy management
- Asset Management and Utilization Optimization

Role of Distribution Planning

You can't predict the future but you can plan for it

What is Your Image of the T&D Future?

Global, Digital, Mobile, Virtual, and Personal

Role of Distribution Planning

- Identify customer service, system reliability, and environmental expectations
- Provide consumer end-use and system-use forecasts
- Provide engineering system assessments using electric facility steady state and operational/dynamic models
- Assure that the year to year distribution additions have a good chance of reaching their planned economic life
- Consider economics, reliability, power quality, safety, new technologies, and public acceptance when planning
- Identify right of way and land requirements for future expansion of substations and lines
- Recommend electric system design and operational guidelines

Why Smart Grids are Needed

- Distribution System Deficiencies
  - Little flexibility and intelligence
  - End of useful life
  - End-use load variations
  - Little visibility
  - Legacy Network
  - Efficiency
- Consumer Cost of Service Issues
- Environmental Issues
- New Technology Advancements
  - Transportation
  - Advanced metering
  - Power electronics
  - Changing End-use Loads (nonlinear)
  - Communication networks
- Higher Cost of Energy Resources
- Dispersed Generation

What will Smart Grids look like

- Low cost sensors and smart meters
- Distributed information and intelligence
- Smart systems and controls
- Distributed energy resources
- High temperature superconducting materials
- High efficiency transformers
- Improved fault limiting devices

What will Smart Grids look like

- Electricity storage devices
- Power electronics (switches and controllers)
- Customer smart appliances
- Communication system infrastructures
- Distribution substation automation and control
- Improved fault locating and prediction
- Improved Protection and fault isolation

What are the Distribution Planning Tools Needed for Smart Grid Planning?

1. Enhanced Distribution System modeling and simulation

- 8760 hour consumer load profile simulation for voltage and reliability
- Dispersed generation and control modeling with bi-directional flows
- Customer end-use appliance and demand response modeling
- Value based predictive reliability and system operation modeling
- Near real time, short term, and long range planning modeling
- System protection, stability, demand response, load control modeling
- Modeling of both primary and secondary distribution systems
- Three phase bi-directional closed network power flow modeling
- Probability applications for normal and contingency operation modeling
- Data interfaces with GIS and customer information systems

2. Expanded Distribution system design and operational guidelines

- Substation power transformer loading higher utilization factors
- Distribution transformer loading higher utilization factors
- Distribution circuit loading higher utilization factors
- Automated system isolation and load restoration practices
- System voltage and Power Quality control procedures
- Distribution generation connection and control guidelines
- Customer metering interface and communication guidelines
- New equipment design specifications and application guidelines
- Distribution substation automation planning guidelines

3. Greater emphasis on system efficiency, cost allocation, and loss reduction

- Value based assessments, financial risk, and cost optimization
- Power quality, reactive load, and voltage management
- Green circuit low loss initiatives
- Conservation voltage regulation implantation
- Conductor economic optimization applications
- Transformer sizing and loss optimization analysis
- Distribution system customer total cost of service minimization
- Optimization of equipment control settings

4. Expanded distribution small area load forecast capability

- Prediction of consumer load profile and load characteristic uses
- Coordination of land use designations and long range build out plans
- Population and jobs, local area commerce, consumer characteristics
- Stochastic methods applied to generation proliferation and demand response
- Stochastic methods applied for distribution line loading and expansion models
- Cost of future energy resource mix
- Longer range and distribution strategic planning time frame

Estimating Cost of CO_2 MITIGATION

Veronika A. Rabl

Principal
Vision & Results
Washington, DC

VISION AND RESULTS

Objective

- Estimate mitigation costs and potential reductions
  - in the near term, ~ next 10 years
  - (results for US, but similar for the same technologies in other industrialized countries)
- Derive abatement supply curve, including uncertainties

Methodology

- Literature Review
  - We reviewed about 250 studies. Of these about 25 were studied closely and used for our calculations
  - Units: tCO2 = metric ton of CO2
- Normalized data to consistent assumptions
  - EIA baseline
  - input parameters include uncertainty range

Methodology, cont.

- Societal Perspective
  - constant currency and social discount rate (generally 5%).
  - Taxes are not included
- Fuel Costs
  - vehicle sector $1.50/gallon of gasoline and of diesel fuel, without taxes.
  - Natural gas $5.0/MBTU ($4.74/GJ) and for coal $1.3/MBTU ($1.23/GJ).

Methodology, cont.

- For direct emissions we consider only CO_2
- For fuel production upstream emissions are important:
  - upstream impacts via LCA (life cycle assessment)
  - including CH_4 and N_2O as CO_2 equivalent
- Carbon capture and sequestration (CCS)
  - include a nominal cost for transport and storage

    $6.7 (+2.3/-2.5)/tCO_2$ captured

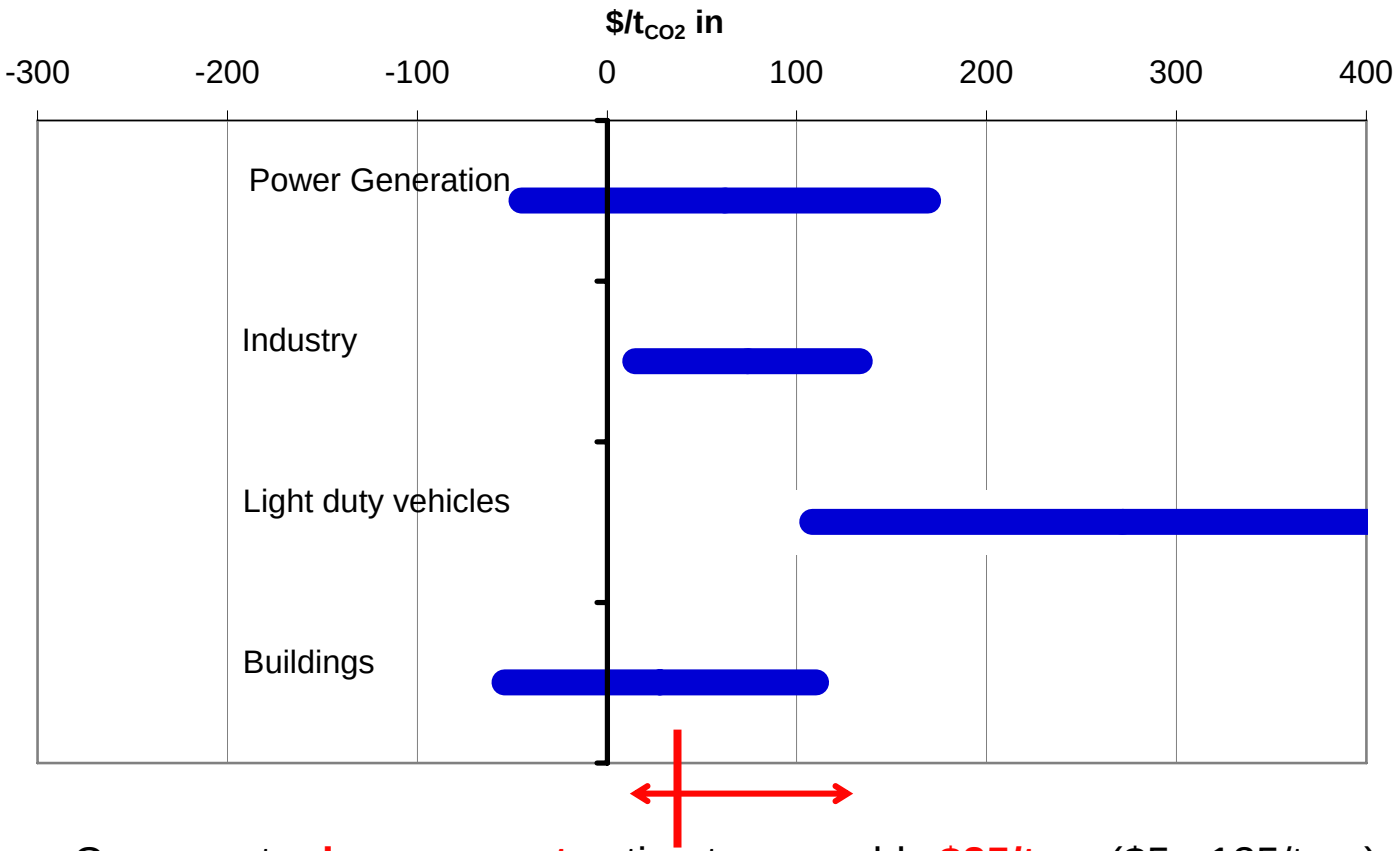
Potential Reductions

Sector	*Total emissions*	*Near term reductions*	
	Mt_{CO2}/yr	*Mt_{CO2}/yr*	*% of total*
Power	2,619	358	**14%**
Industry	755	14.1	**2%**
Vehicles	745	33.6	**5%**
Buildings	2,553	40	**2%**
Total	6,672	446	**7%**

Limitations

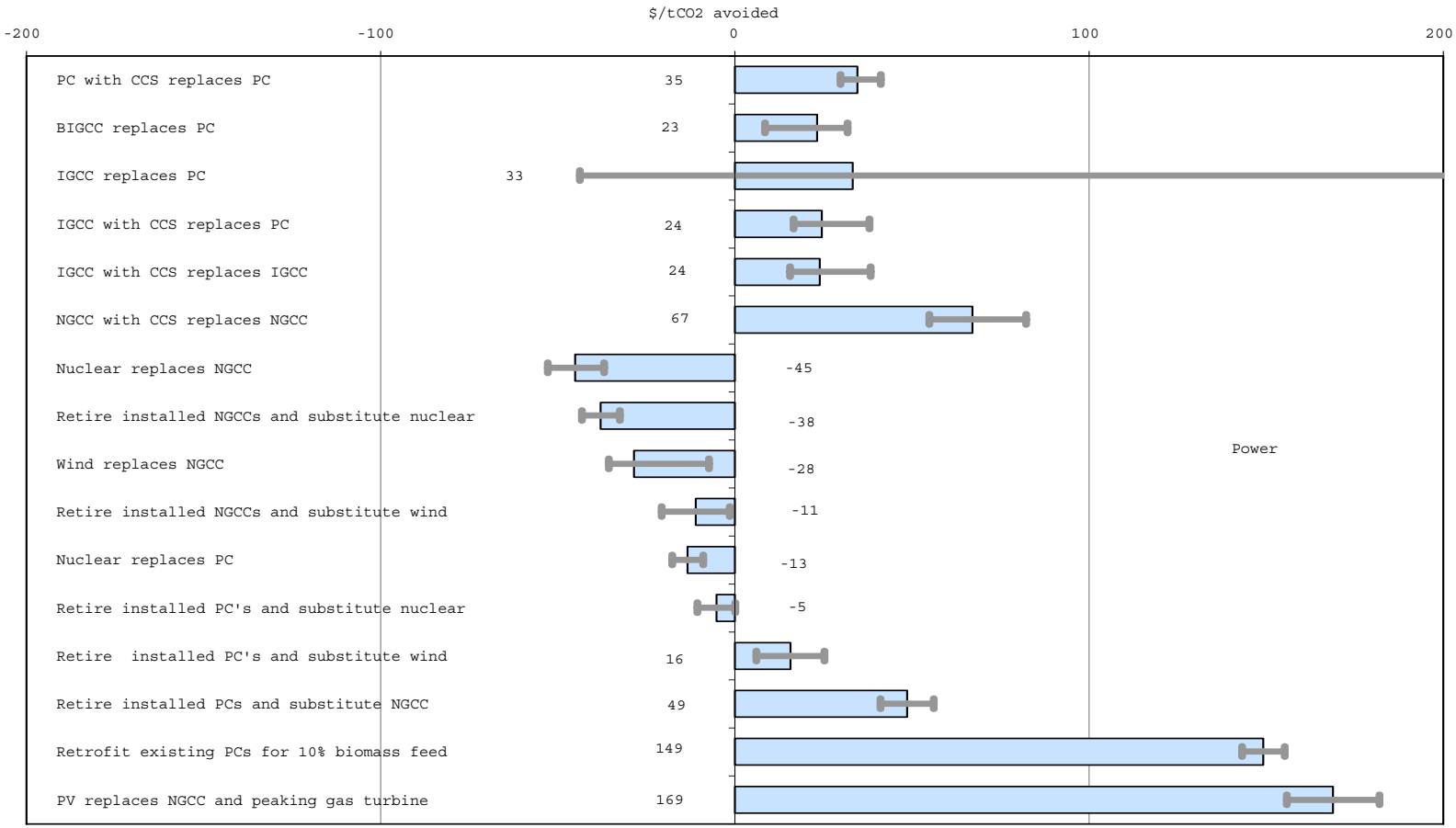
- Power: good coverage
- Buildings and industry: fair coverage (not all costs for 5%, lack of data)
- Vehicles: only cars and light trucks:
  - conventional -> hybrid or diesel,
  - gasoline -> corn ethanol, diesel -> biodiesel

Costs

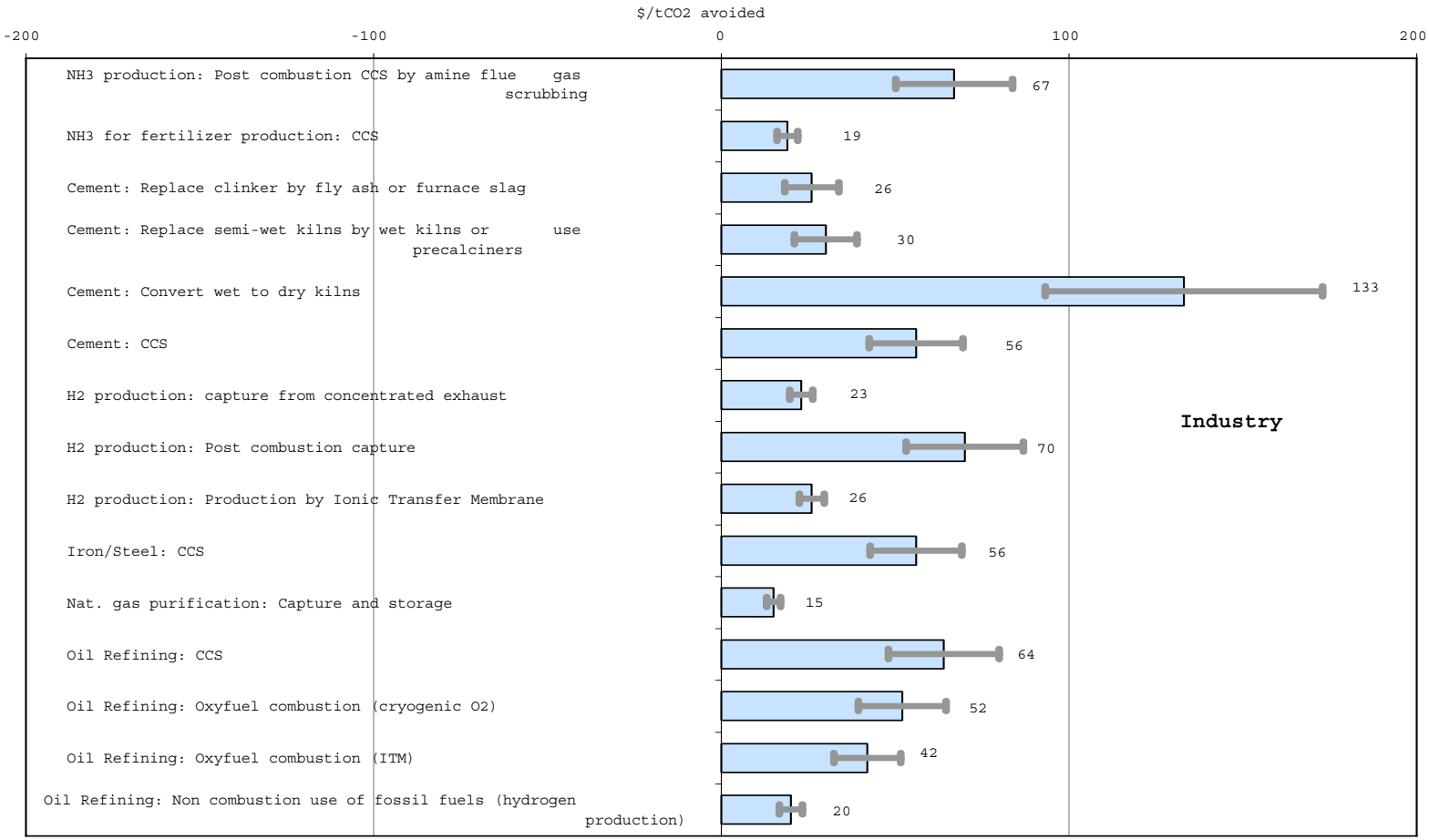


Compare to **damage cost** estimates: roughly **$25/$t_{CO2}$** ($5 - 125/t_{CO2})

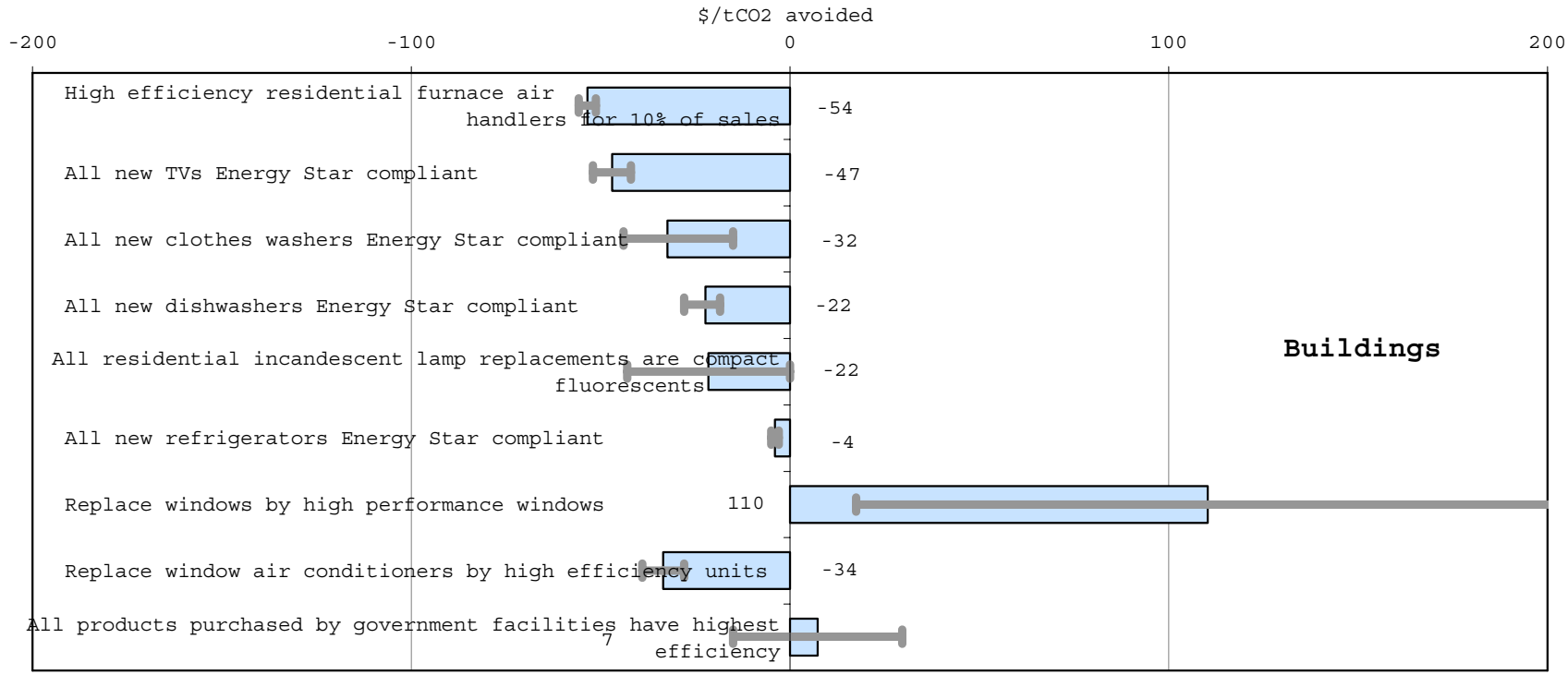
Power Generation



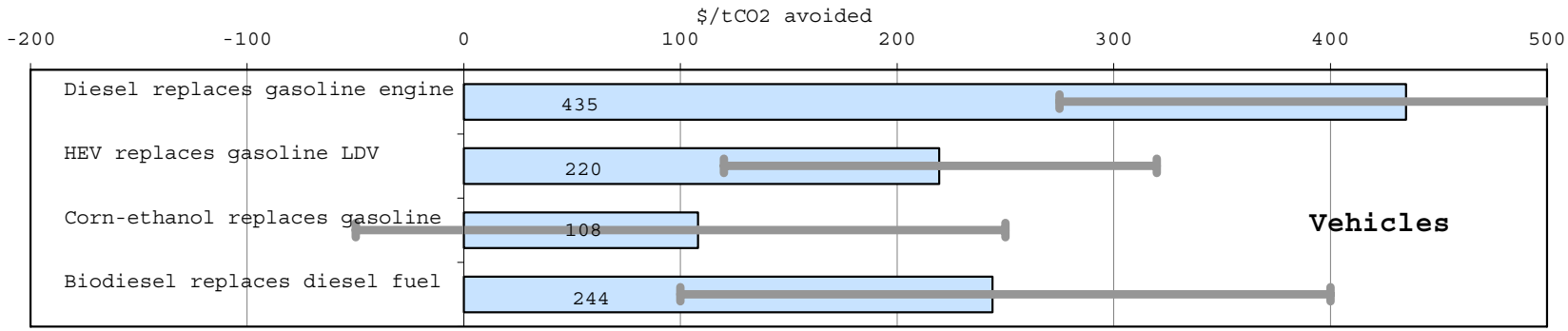
Industry


$/tCO2 avoided
-200
-100
0
100
200
NH3 production: Post combustion CCS by amine flue gas scrubbing
67
NH3 for fertilizer production: CCS
19
Cement: Replace clinker by fly ash or furnace slag
26
Cement: Replace semi-wet kilns by wet kilns or use precalciners
30
Cement: Convert wet to dry kilns
133
Cement: CCS
56
H2 production: capture from concentrated exhaust
23
H2 production: Post combustion capture
70
H2 production: Production by Ionic Transfer Membrane
26
Iron/Steel: CCS
56
Nat. gas purification: Capture and storage
15
Oil Refining: CCS
64
Oil Refining: Oxyfuel combustion (cryogenic O2)
52
Oil Refining: Oxyfuel combustion (ITM)
42
Oil Refining: Non combustion use of fossil fuels (hydrogen production)
20
Industry

Buildings

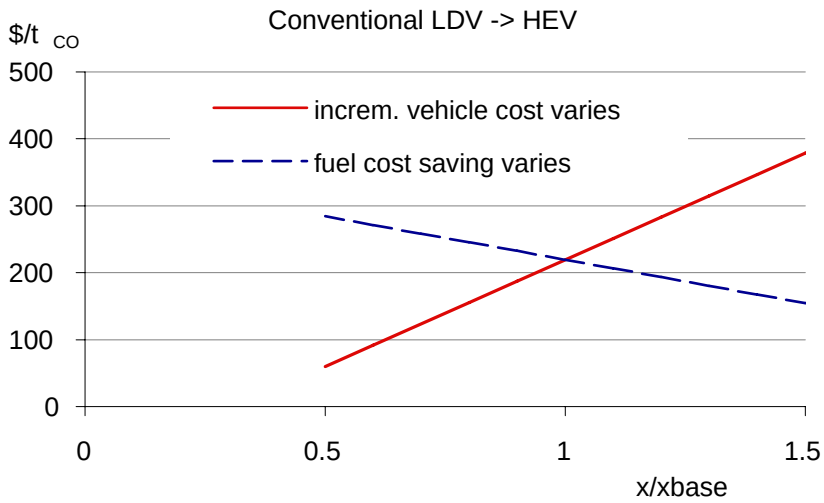

$/tCO2 avoided
-200
-100
0
100
200
High efficiency residential furnace air handlers for 10% of sales
-54
All new TVs Energy Star compliant
-47
All new clothes washers Energy Star compliant
-32
All new dishwashers Energy Star compliant
-22
All residential incandescent lamp replacements are compact fluorescents
-22
All new refrigerators Energy Star compliant
-4
Replace windows by high performance windows
110
Replace window air conditioners by high efficiency units
-34
All products purchased by government facilities have highest efficiency
7
Buildings

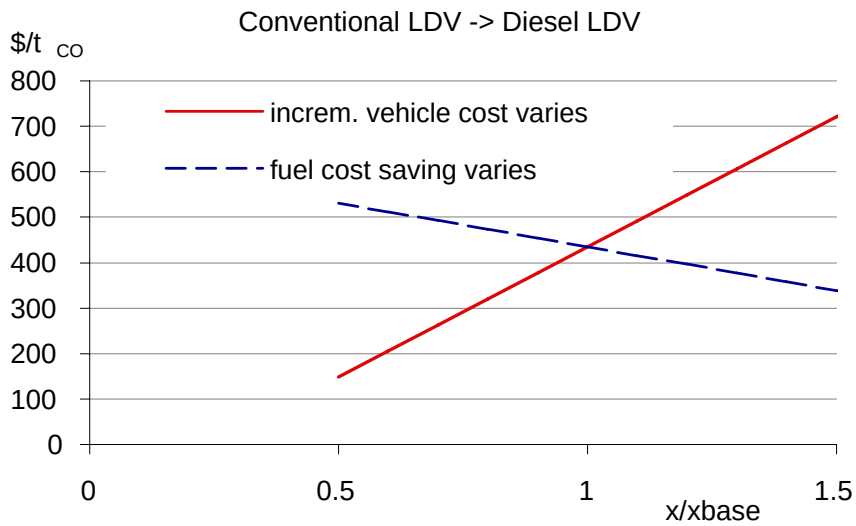
Vehicles


$/tCO2 avoided
-200
-100
0
100
200
300
400
500
Diesel replaces gasoline engine
435
HEV replaces gasoline LDV
220
Corn-ethanol replaces gasoline
108
Biodiesel replaces diesel fuel
244
Vehicles

VISION AND RESULTS

Sensitivity to vehicle price

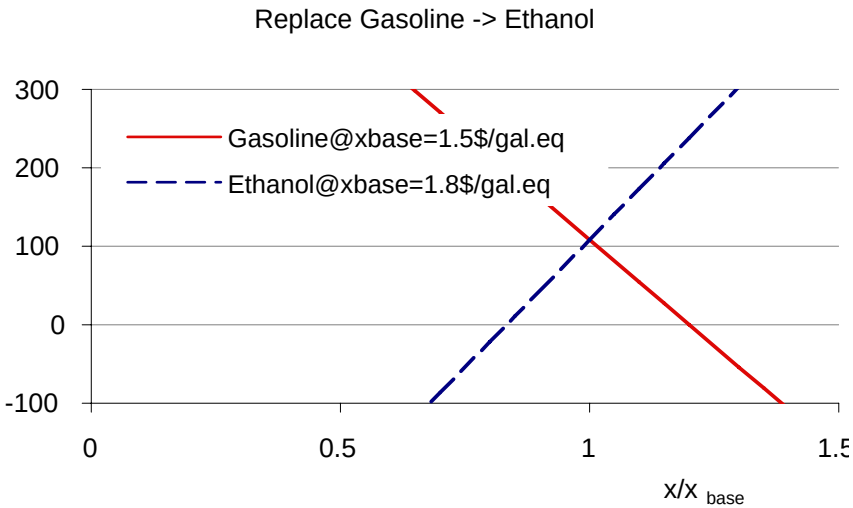


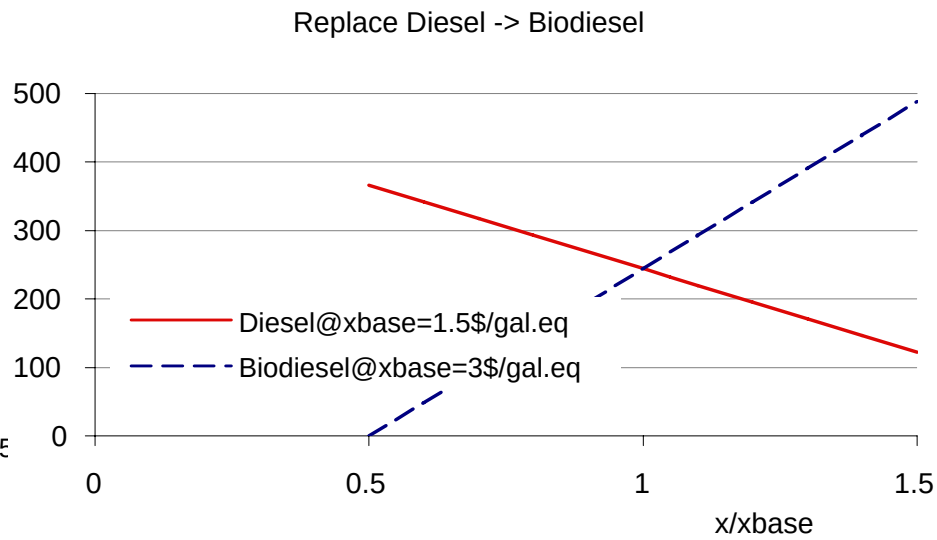


x_{base}	fuel cost, $/gal	increm. vehicle cost, $
HEV	1.5	4200
Diesel	1.5	4600

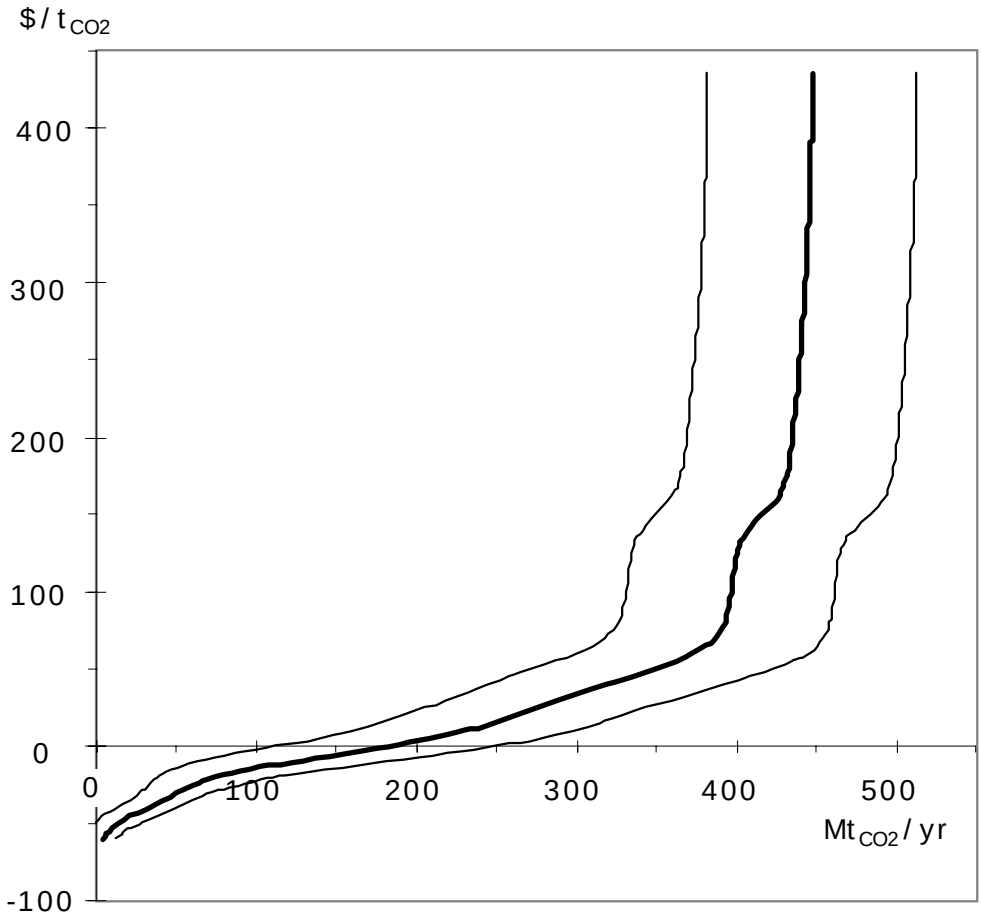
VISION AND RESULTS

Sensitivity to fuel cost





Supply curve



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Vehicles	745	33.6	5%
Buildings	2,553	40	2%
Total	6,672	446	7%

*But note: **Long term** supply curve is **much lower** (learning and progress)*

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