Benefits Analysis Considering Uncertainty
Stochastic Energy Deployment System (SEDS) Model

R&D Portfolio Analysis Workshop
Walter Short
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Market Models at NREL Used in R&D Planning

- SolarDS
- ReEDS
- BSM
- SEDS
- GridView
- SERA
The World is Stochastic

Annual Electric Generating Capacity Additions

- Coal
- Natural Gas
- Nuclear

Gas declines (PIFUA prohibits)
Gas increases (50+ GW added in 2002)
Technology Available
Too cheap to meter
Interest rates
3-Mile Island (1979)
Chernobyl (1986)
Regulation
Low price through deregulation
Nuclear declines
Nuclear emerges
CAMA deregulation
63 GW
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SEDS Process

Oil Import Reduction (Bil)

Commercial PV System Costs

Unit capital cost in 2030 ($/kW)

Uncertain Inputs → Yield → Uncertain Outputs

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Uncertainty Can Provide a Different Perspective
Cumulative New Generation (2010-2050) by Technology

1. Base Deterministic
2. Add General Technology Uncertainty
3. Add Fuel Price Uncertainty
4. Add Macroeconomic Uncertainty

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Uncertainty Can Provide a Different Perspective (2)
Cumulative New Generation (2010-2050) by Technology

5. Add Carbon Uncertainty

6. Add EERE R&D Uncertainty

Compare with the Start Point

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Stochastic Energy Deployment System Modules

- Macroeconomics
  - Biomass
  - Coal
  - Natural Gas
  - Oil

- Primary Energy
  - Biofuels
  - Electricity
  - Hydrogen
  - Liquid Fuels

- Converted Energy
  - Buildings
  - Heavy Transportation
  - Industry
  - Light Vehicles

- End-Use

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Example Benefit Analysis - LDVs

**Capital Costs**

- Year 2020
- Year 2040

**Fuel Efficiency**

- Year 2020
- Year 2040

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Example Benefit Analysis – LDVs (2)

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Example Benefit Analysis – LDVs (3)
Effect of Improvements in Technologies

- **Consumer Savings (Bil. 2009$/yr)**
  - Graph showing savings over time from 2005 to 2050.

- **CO2 Reduction (Mil. tCO2/yr)**
  - Graph showing CO2 reduction over time from 2005 to 2050.

- **Oil Import Reduction (Bil. Bbl/yr)**
  - Graph showing oil import reduction over time from 2005 to 2050.

- **Nat. Gas Import Reduction (BCF/yr)**
  - Graph showing natural gas import reduction over time from 2005 to 2050.

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R&D Uncertainty vs. Program Funding and Goals

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Combining Scenario and Uncertainty Analysis

![Graph showing CO2 emissions by scenario (M tons CO2/y)]

- **Scenario**
  - 1. Base
  - 2. Nuclear
  - 3. Low Gas
  - 4. 20% RPS
  - 5. Overtarget R&D
  - 6. 60$/ton CO2 Tax
  - 7. All except cap
  - 8. Carbon Cap 1.8Gton
  - 9. Cap 1.8Gton, RPS, nukes, R&D

- **CO2 emissions by scenario (M tons CO2/y)**

- **Percentiles**
  - 5%
  - 25%
  - 50%
  - 75%
  - 95%

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Questions?