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Harnessing the Upper Midwest's Bioenergy Potential

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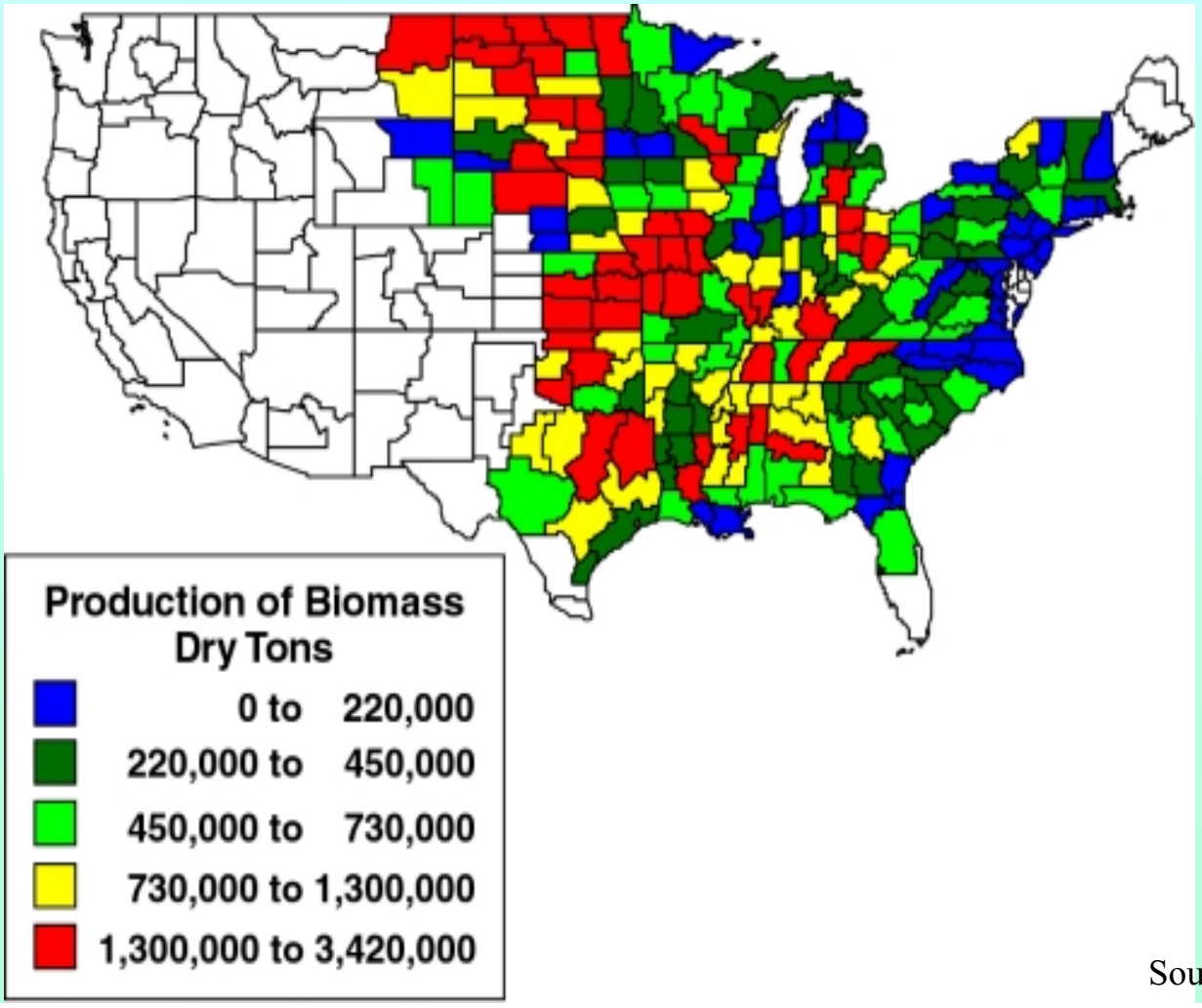
Growing energy on the farm

US Energy Crop Potential in 2008, under $50/dry ton delivered



- **Energy crops and crop residues could provide 14% of US electricity use by 2008 or 13% of US motor fuel.**
- **Potential to increase net farm income by ~$8 billion/year.**
- **Upper Midwest has 29% of US energy crop potential and 42% of ag residues.**

Source: Oak Ridge National Lab, US DOE

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ORNL Assumptions for Switchgrass Potential

- Quantities based on relative profit of energy crops vs. traditional crops and alternative land uses
- Includes cropland acres planted in traditional crops, idled, pasture, and CRP program
- Limits acres that can shift to other crops
- Limited to areas climatically suited for their production
- Assumes recommended management practices
- Switchgrass produced for 10 years before replanting
- Yield of ~4-5 dry tons/acre

Source: Oak Ridge National Lab, *Biomass Feedstock Availability in the US*, 2000.

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ORNL Assumptions for Agricultural Residues

- **Only includes corn stover and wheat straw**
- **30-40% of residues collected to maintain soil quality**
- **Includes $20/ton for farmer profit and transportation**

Source: ORNL, 2000.

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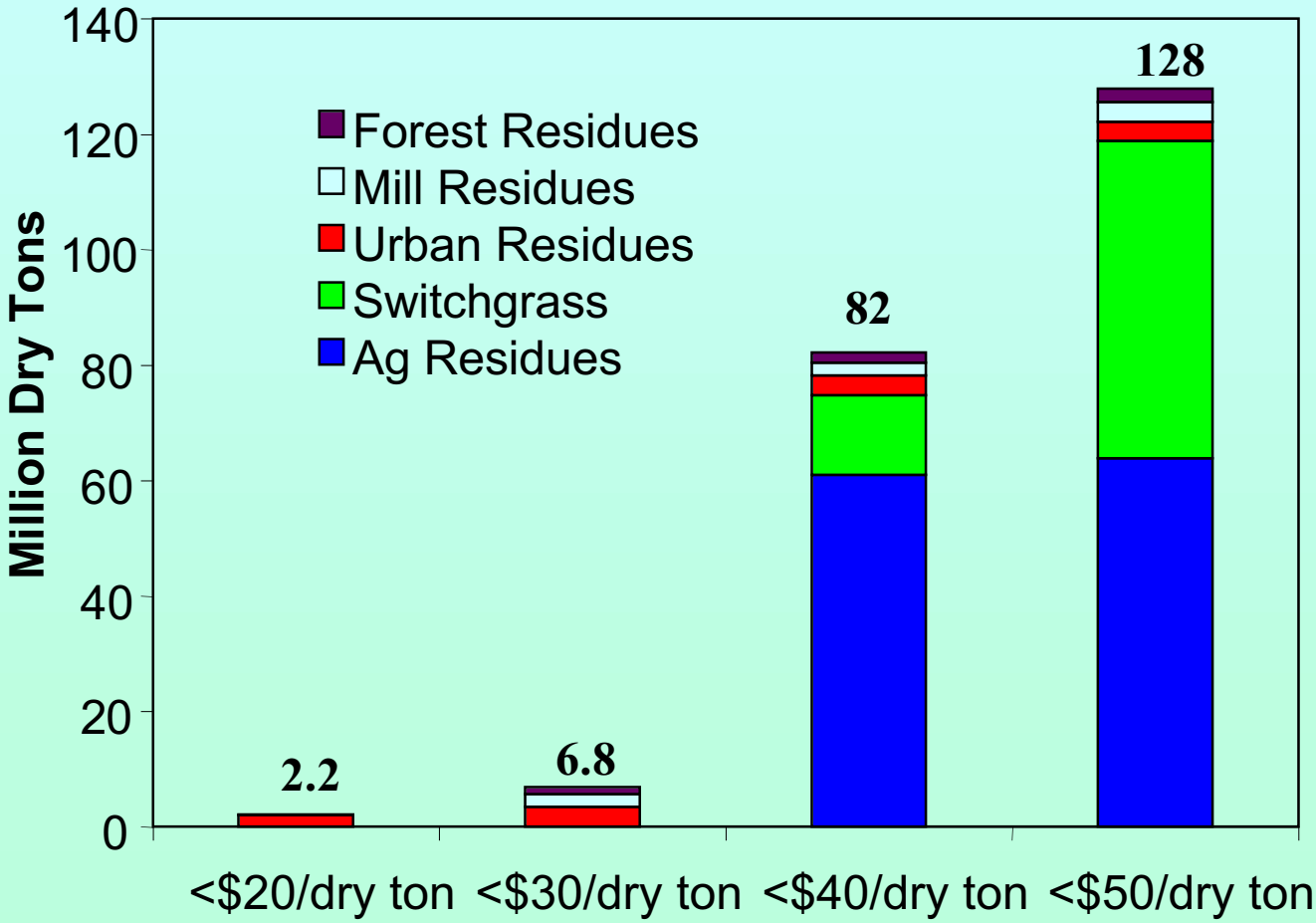
Upper Midwest Biomass Potential



✷ **25% of total US potential at <$50/dry ton (~$3/Mil. Btu)**

Source: ORNL, 2000. Includes Iowa, Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin.

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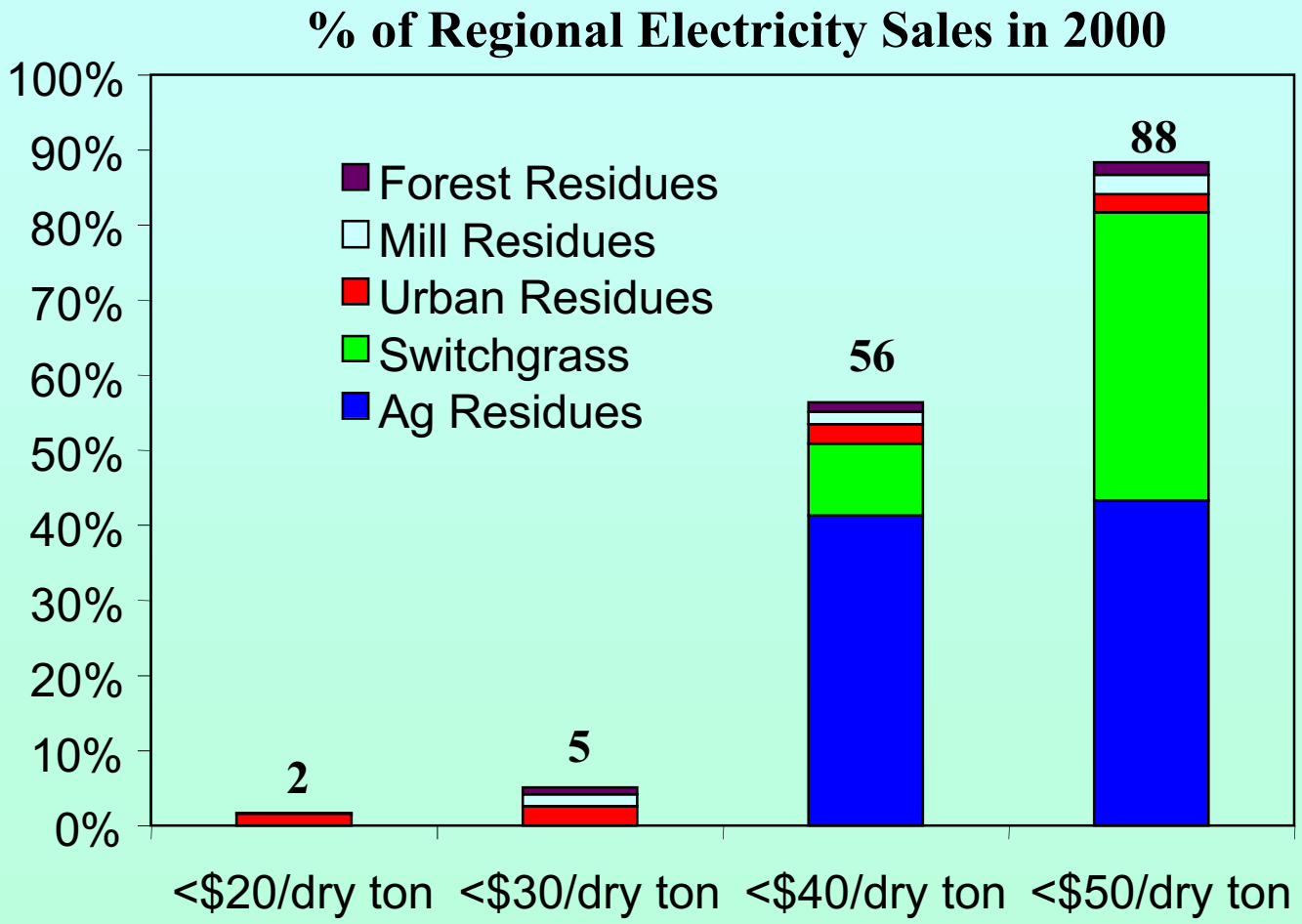
Upper Midwest Biopower Potential



Source: ORNL, 2000. EIA. Includes Iowa, Minnesota, Nebraska, North Dakota, South Dakota, and Wisconsin.

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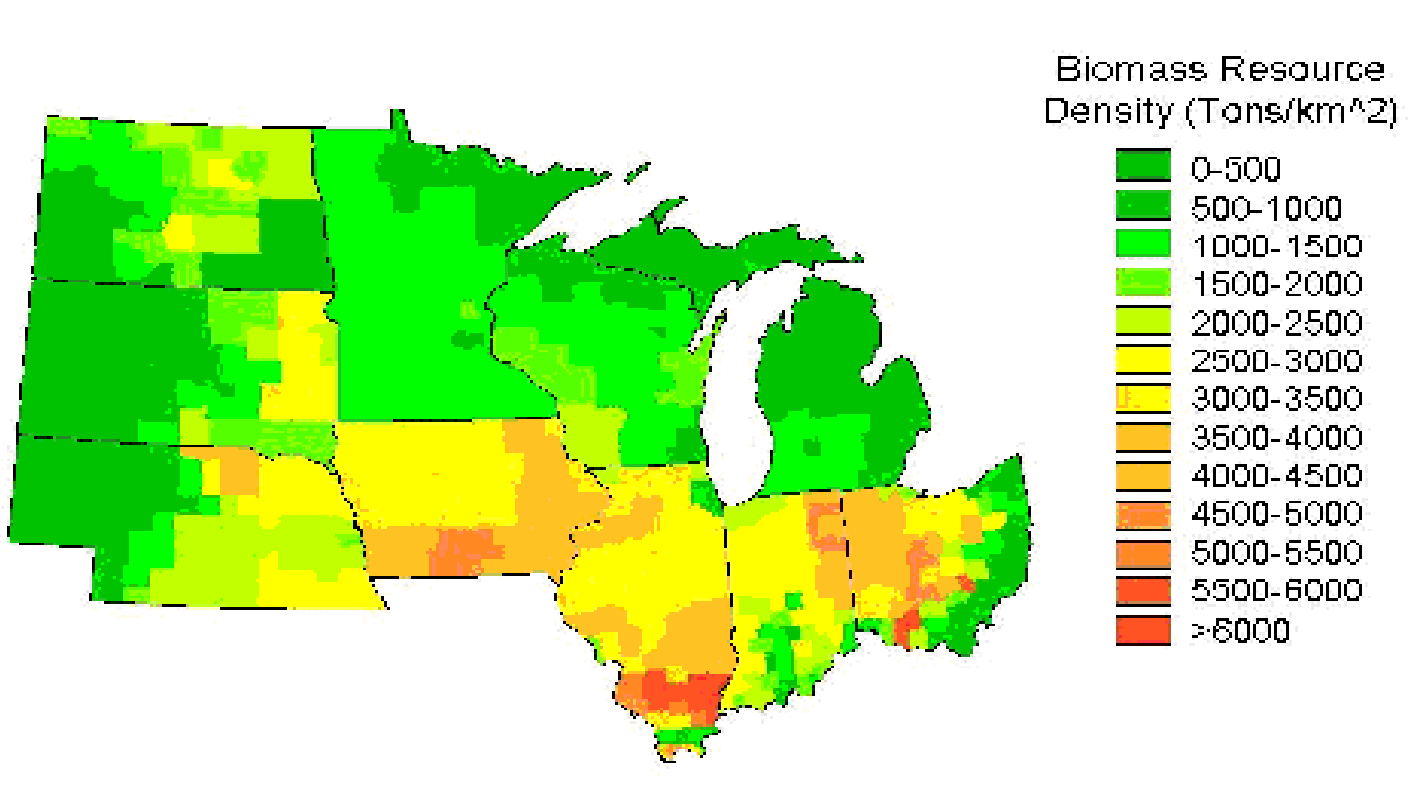
Biomass Distribution at $37.5/dry ton ($2.25/MMBtu)



Source: Repowering the Midwest, based on data from ORNL. Includes energy crops, crop residues, and forestry residues.

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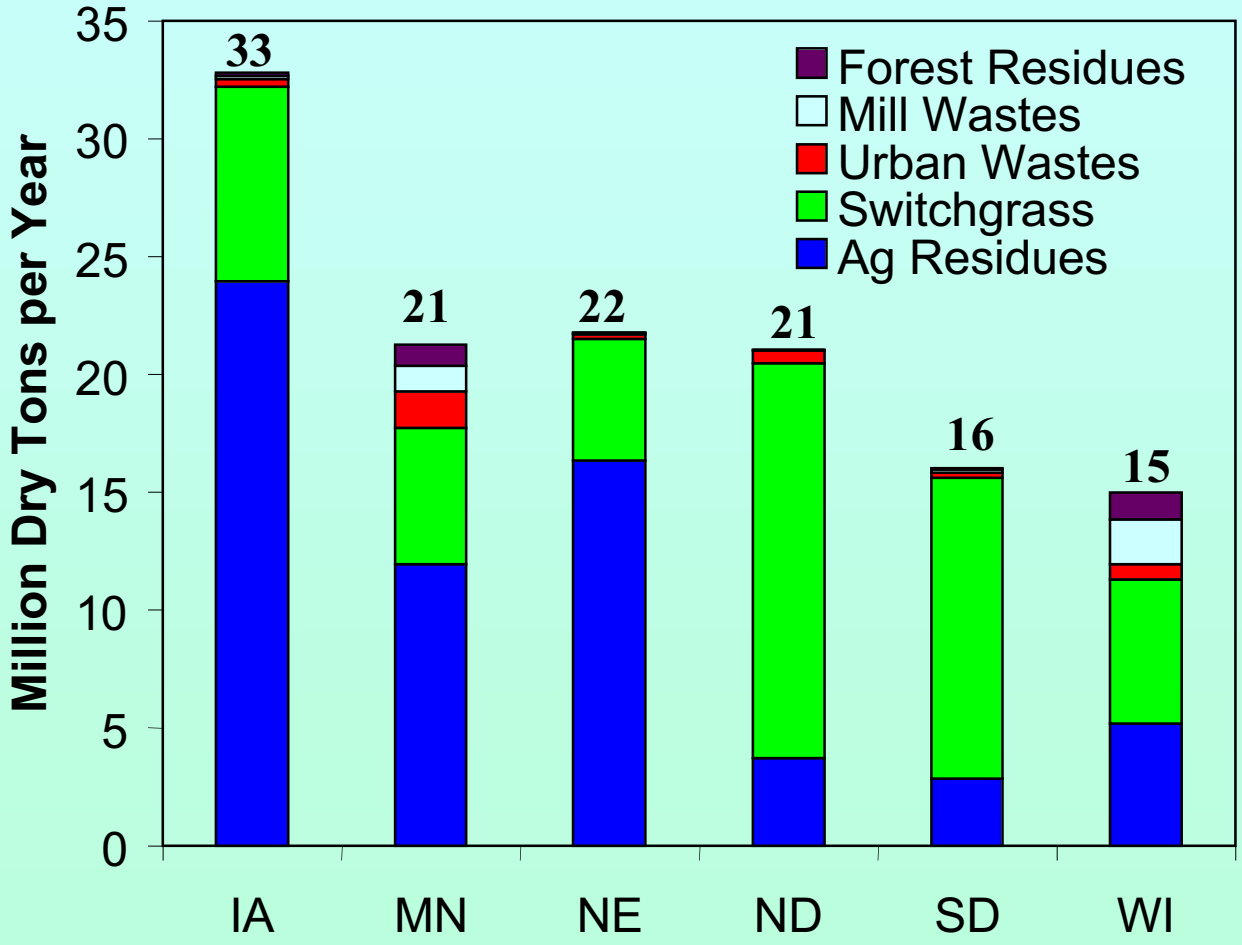
State Biomass Potential
under $50/dry ton



Source: ORNL, 2000.

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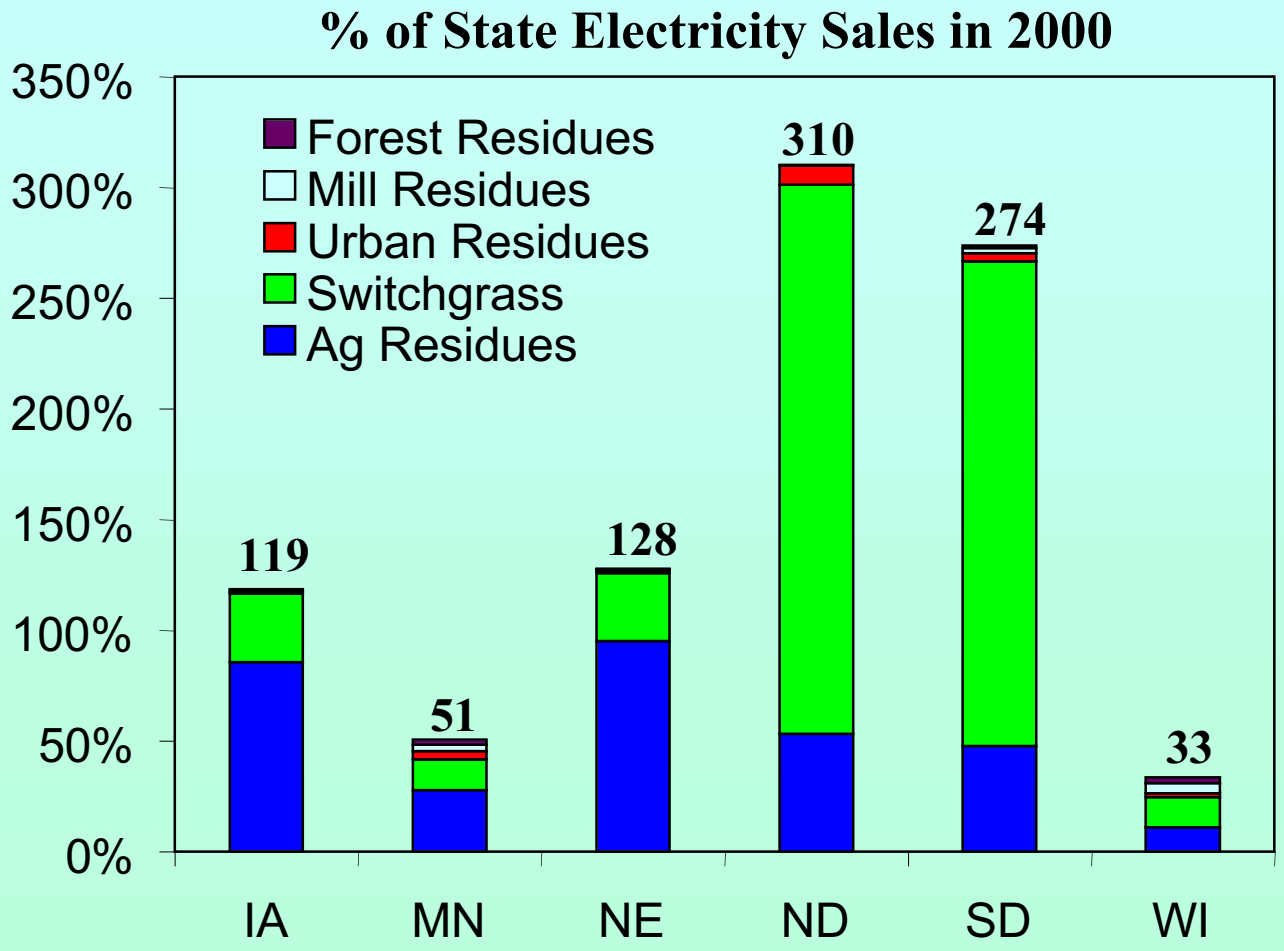
State Biopower Potential under $50/dry ton



Source: ORNL, 2000; EIA.

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Biopower Conversion Technologies

- **Biomass cofiring with coal**
  - **Incremental cost of ~1-2 c/kWh (EPRI/DOE)**
  - **little capital investment required, reduce emissions, commercial**
- **Combined heat and power**
  - **2.3-3 c/kWh (Repowering the Midwest)**
  - **up to 80% efficiency, commercial, used in forest products industry**
- **Biomass gasification**
  - **~7 c/kWh today, declining to ~5 c/kWh in 2020 (EPRI/DOE)**
  - **~40% efficiency, successful demonstrations, more R&D needed**

*Assumes biomass cost of $2.25/MMBtu and 85% capacity factor.

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Key Policies for Harnessing Biomass Potential

- **Renewable Portfolio Standard for electricity**
  - **20% by 2020 (S. 1333 -- Sen. Jeffords)**
  - **10% by 2010 (S. 1766 -- Sens. Daschle/Bingaman)**
- **Renewable Fuels Standard for transportation**
  - **2.5-5% by 2015 (Sens. Daschle/Bingaman--S. 1766 & S. 670; Sen. Hagel/Johnson--S. 1006; Sen. Harkin--S. 892; Rep. Thune--HR 2423)**
- **Production tax credits and incentives**
  - **Extend for at least 5 years and expand to include clean biomass residues and cofiring in coal plants (several proposals in Congress)**
- **R,D&D**
  - **Farm bill: Clean energy title includes over $500 million in incentives for renewables and efficiency**
  - **$49 million for 5 years in R&D for "biobased industrial products"**
- **State renewable energy standards and funds**

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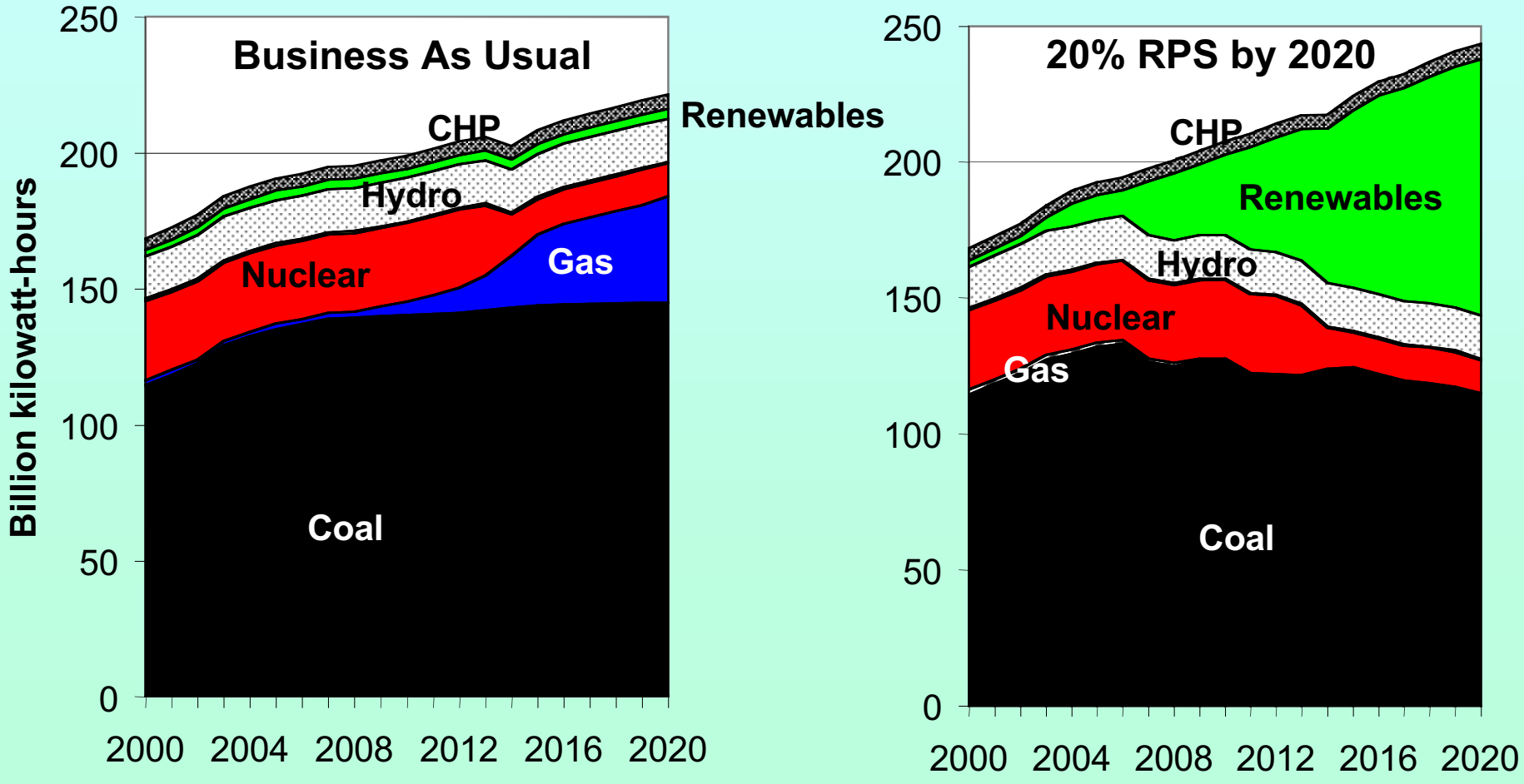
Upper Midwest electricity generation

Business as Usual vs. 20% RPS



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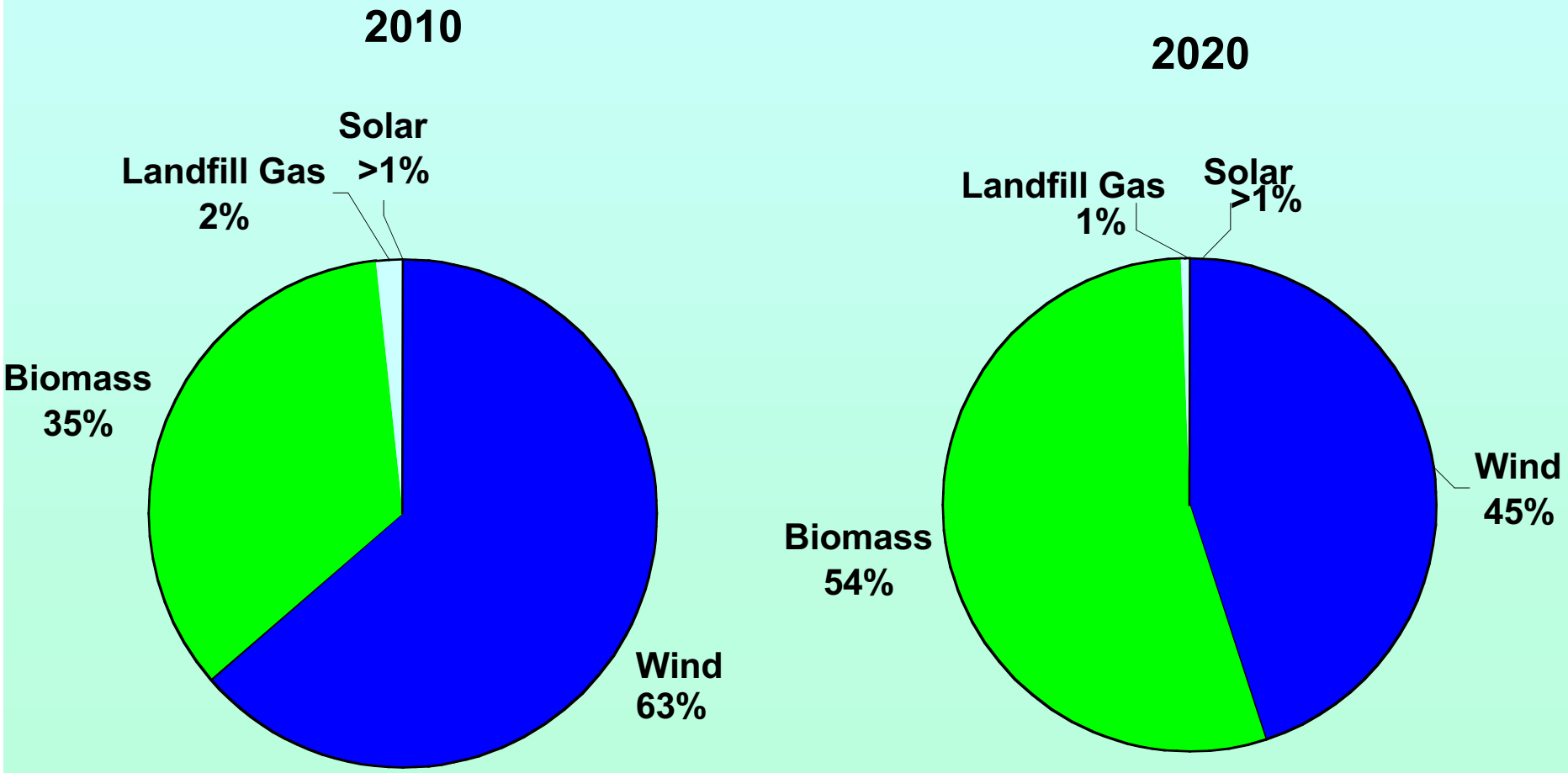
Renewable Generation in Upper Midwest under 20% RPS



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Regional Benefits of 20% RPS by 2020

- **$13 billion of new investments in renewable technologies**
- **$6.7 billion in revenues from exporting renewable energy credits**
- **$700 million in property tax revenues for rural areas**
- **$600 million in savings on consumer energy bills**
- **30% reduction in carbon emissions**

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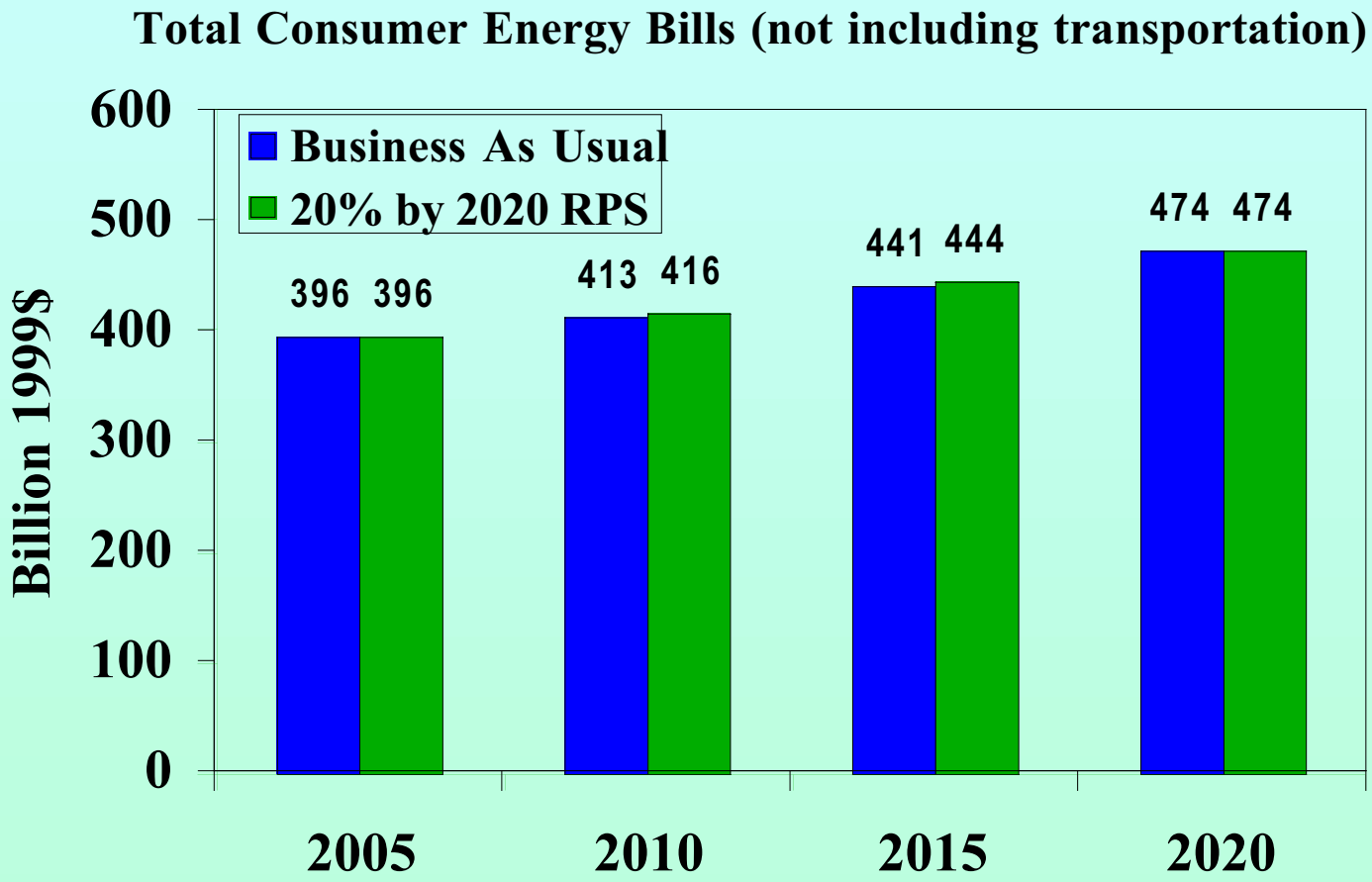
EIA: A 20% National RPS is Affordable



Source: EIA, *Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants*, July 2001, Table E3.

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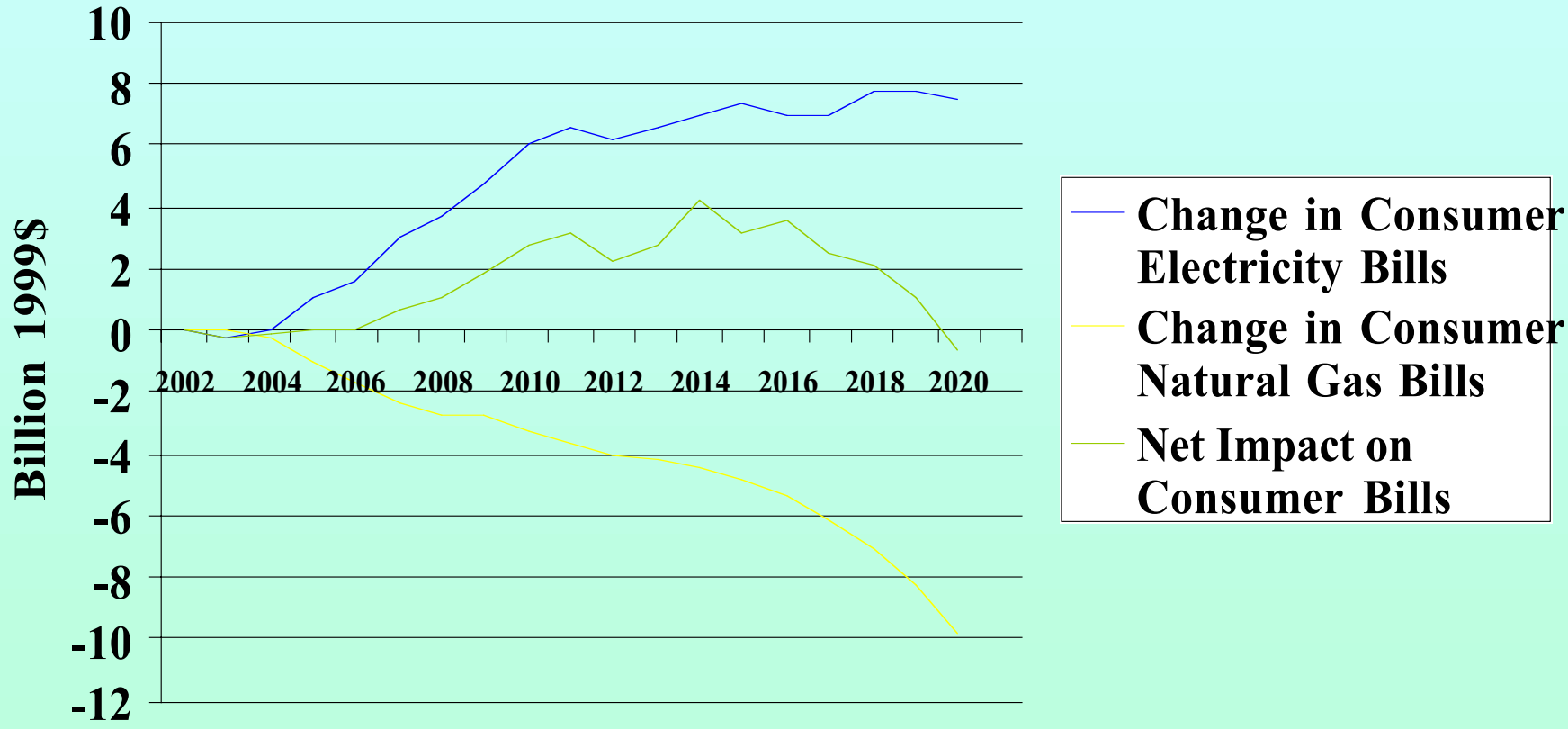
EIA: Consumer gas savings offset higher electricity costs of 20% RPS



Source: EIA, *Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants*, July 2001, Tables E2 and E3, not including refinery energy consumption or transportation.

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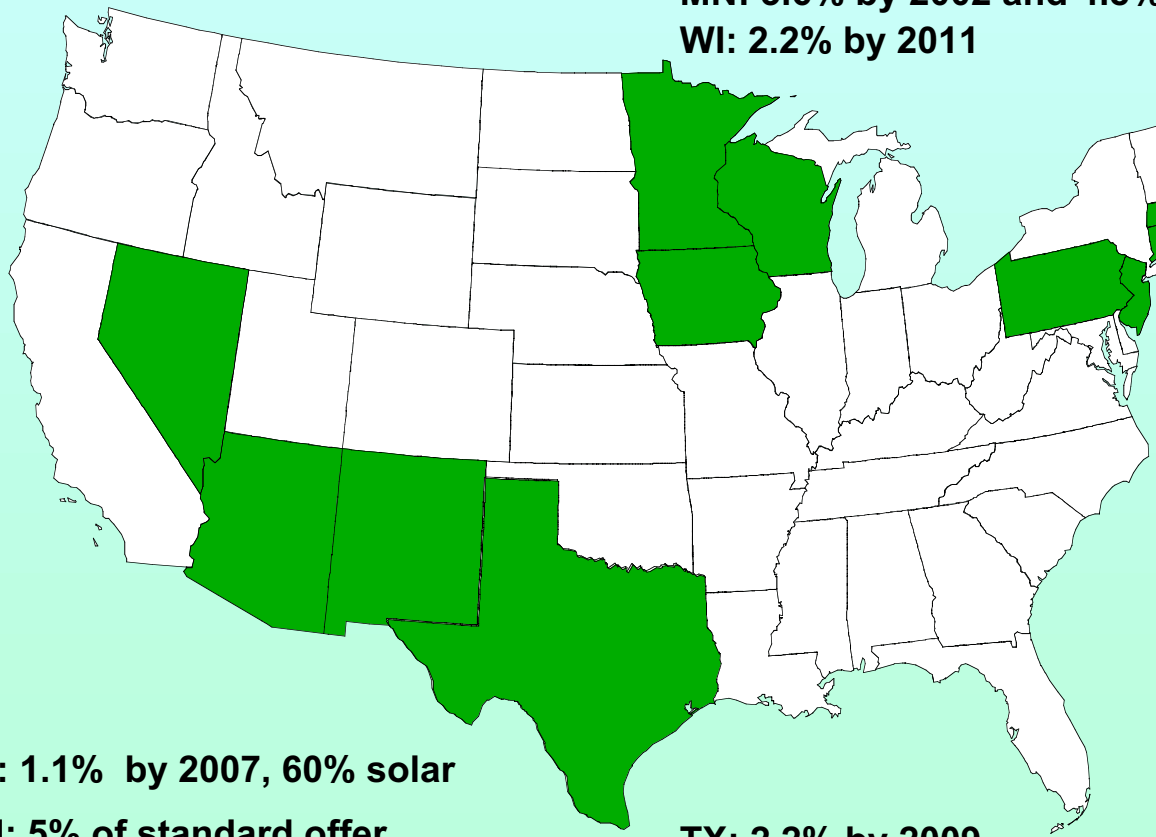
Renewable Energy Standards



IA: 2% by 1999
MN: 3.6% by 2002 and 4.8% by 2012
WI: 2.2% by 2011

ME: 30% by 2000

MA: 4% by 2009

CT: 13% by 2009
NJ: 6.5% by 2012
PA: varies by utility

✷ 12 states

AZ: 1.1% by 2007, 60% solar
NM: 5% of standard offer
NV: 15% by 2013, 5% solar

TX: 2.2% by 2009

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Conclusion

- **The Upper Midwest bioenergy potential is huge**
- **The economic and environmental benefits are significant.**
- **Strong marketed-oriented policies are needed to capture this potential**