A Renewable Energy Initiative for Colorado

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Goals

- Reduce fossil fuel dependency
- Increase renewable energy production
- Provide cheap, efficient, clean energy to the state of Colorado
- Increase reliability on domestic energy sources
- Obtain 15% renewable energy by 2020
  - 3.75 TWh of residential electricity
Existing Renewables

- 2001 Data (Residential Equivalent)
  - Residences use 33% of Colorado’s electricity
  - Wind - 0.05 TWh
  - Hydro - 0.92 TWh
- Total – 0.97 TWh
  - Renewable energy production
Existing Energy Usage

Colorado's Residential Electricity Consumption, 2001 (TWh)

- Coal (11.3)
- Natural gas (2.6)
- Petroleum (0.1)
- Hydro (0.37)
- Wood (0.01)
- Wind (0.01)
- Import (0.002)
Predicted Consumption

- Residential Electricity
  - 2003 Consumption
    - 15.7 TWh
  - 2020 Predicted Consumption
    - 28 TWh
    - Based on exponential regression from historical data
  - 2020 Estimate with Conservation
    - 25 TWh
    - Peak rate adjustments expected to cut consumption

Average Residential Cost Per kWh (cents)

Percent U.S. Residential Electricity Consumption
Predicting Consumption

Predictions based on exponential regression of historical data

Conservation based on a 0.6% per year decrease
  - 3.5% growth without conservation
  - 2.9% growth with conservation
The Initiative

- **PV on Every Home**
  - Beginning next year, every new home built will be required to have installed a photovoltaic system
- **Installation of 1.5-10 kW systems**
- **Average 2kW rating across the board**
- **Application**
  - New Houses
  - New Housing Complexes and Apartments
    - 1.5 kW per dwelling

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**Calculating Electricity Bill Savings for a Net-Metered GTPV System**

1. Select your location and $\text{kWh}/\text{kW}$ from the map below.
2. Multiply the kWh/kW-yr times the PV system rating (in kW) to get the yearly PV system production in kWh/yr.
3. Multiply the PV system kWh/yr times your retail rate in $/\text{kWh}$ to get the annual bill savings.

**Example:** A 2-kW system in Denver, CO, at an electricity rate of $0.07/\text{kWh}$ will save about $252 per year ($1,800 \text{kWh/kW-year} \times 2 \text{kW} \times 0.07/\text{kWh} = 252/\text{year}$).
New Home PV Initiative: Homes

- Current Households
  - 1.9 million

- 2020 Households
  - 2.4 million

- New Homes
  - 475,000

Growth of Colorado Households (x1000)

- Historical Data
- Predicted Trendline
New Home PV Initiative: Energy

- Based on a 2kW rated average system
  - 1.81 TWh of renewable energy could be generated on the roofs of Colorado houses/apartment buildings in 2020
  - This represents about 6% of total residential electrical consumption for CO
New Home PV Initiative: Cost

- Example Costs of Installed Systems
  - Modules, inverters, mounts, repair

- 1.5 kW system
  - $8,000 + $1,000 maintenance - $2,000 Federal rebate
  - Remaining Cost: $7,000 - 0.08/kWh

- 2.5 kW system
  - $12,000 + $1,000 maintenance - $2,000 Federal rebate
  - Remaining Cost: $11,000 - 0.08/kWh
Energy Buyback Savings

- $0.08/kWh would be the (current) rate of energy buyback
  - This is a dynamic buyback rate, reflecting current prices
- Based on average price per kWh in CO
- For each excess kWh generated by the PV system, the consumer will receive $0.08 credit on their bill
- For a 2kW rated system (20 yr lifetime)
  - Estimated savings of $280 per year
  - Lifetime savings of $5,600
  - Average cost of system (lifetime)
    $10,000 - $2,000 - $5,600 = $2,400
Present Wind Power in Colorado

- Total Installed Power Capacity
  - 292 MW

- Annual Electric Energy Output
  - 0.6 TWh
Power of Wind Formula

- Power of wind through a perpendicular circular area

\[ P \approx \frac{1}{2} \rho v^3 \pi r^2 \]

- \( P \) = power of the wind (W) through an area (\( \pi r^2 \)).
- \( \rho \) = density of dry air = 1.225 (kg/m\(^3\))
- \( v \) = velocity of wind (m/s)
- \( \pi = 3.141 \)
- \( r \) = radius of the circular area (m), also, the length of one turbine blade.

- Power is essentially the kinetic energy of wind passing through an area

- Power generation largely dependent on wind velocity (cubed) and blade span (squared)
New Wind Farm Proposal

- Xcel Proposed:
  - **400 MW** installed
  - Eastern Colorado
  - Washington County near Akron

- We Suggest:
  - 145 turbines rated at 2.75 MW
  - Over 20,000 acres
Harvesting the Wind

- $450 Million Includes
  - Cost of turbine
  - Installation
  - Maintenance

- Actual Annual Production
  - 0.87 TWh
Energy Rundown

- Existing Renewables
  - 0.97 TWh
- New Home Initiative
  - 1.81 TWh
- Wind Farm
  - 0.87 TWh
- Total Renewable Energy 2020
  - 3.65 TWh
Paying For it All

- Combined cost of wind and solar = $1.6 billion
  - Total cost of wind installation = $0.45 billion
  - Total cost of solar = $1.14 billion
    - $2,400 * 475,000 units = $1.14 billion

- New home PV owners will receive $2,400 in subsidies from Xcel over 14 years
  - Actual breakdown to be determined

- Paid for by small rate increases
  - Average expected annual residential electrical usage
    - 19.8 TWh over 14 year span
  - Rate increase of $0.0058 per kWh
  - $1.6 billion generated over 14 years
  - Average cost to consumer of $4 per month over 14 years
    - Average monthly electric bill in Colorado in 2003 was $56
    - 7% Increase to electric bill
Overall Analysis

500 MW Coal Power Plant Cost
- $1.3 billion total
- Produces 51.8 million tons of CO$_2$
- Produces 3.5 TWh per year at rated power

Energy Bill Cost
- $1.6 billion total
- Produces 2.7 TWh in 2020
Thanks for Listening!