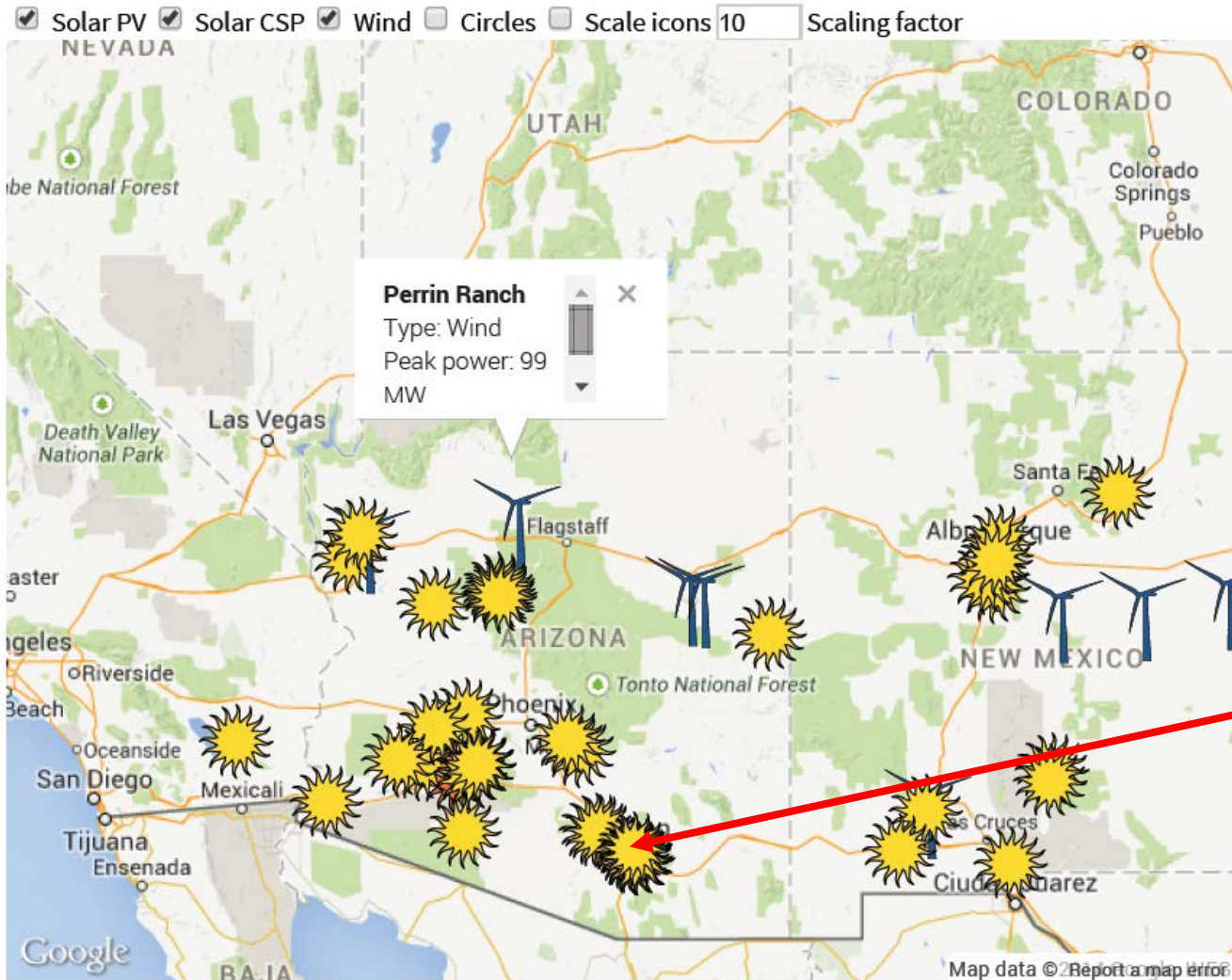


Alex Cronin, UA Professor of Physics

Discuss: Solar, the FEW Nexus, and Policy

<https://sveri.uaren.org/>
<https://forecasting.uaren.org/>

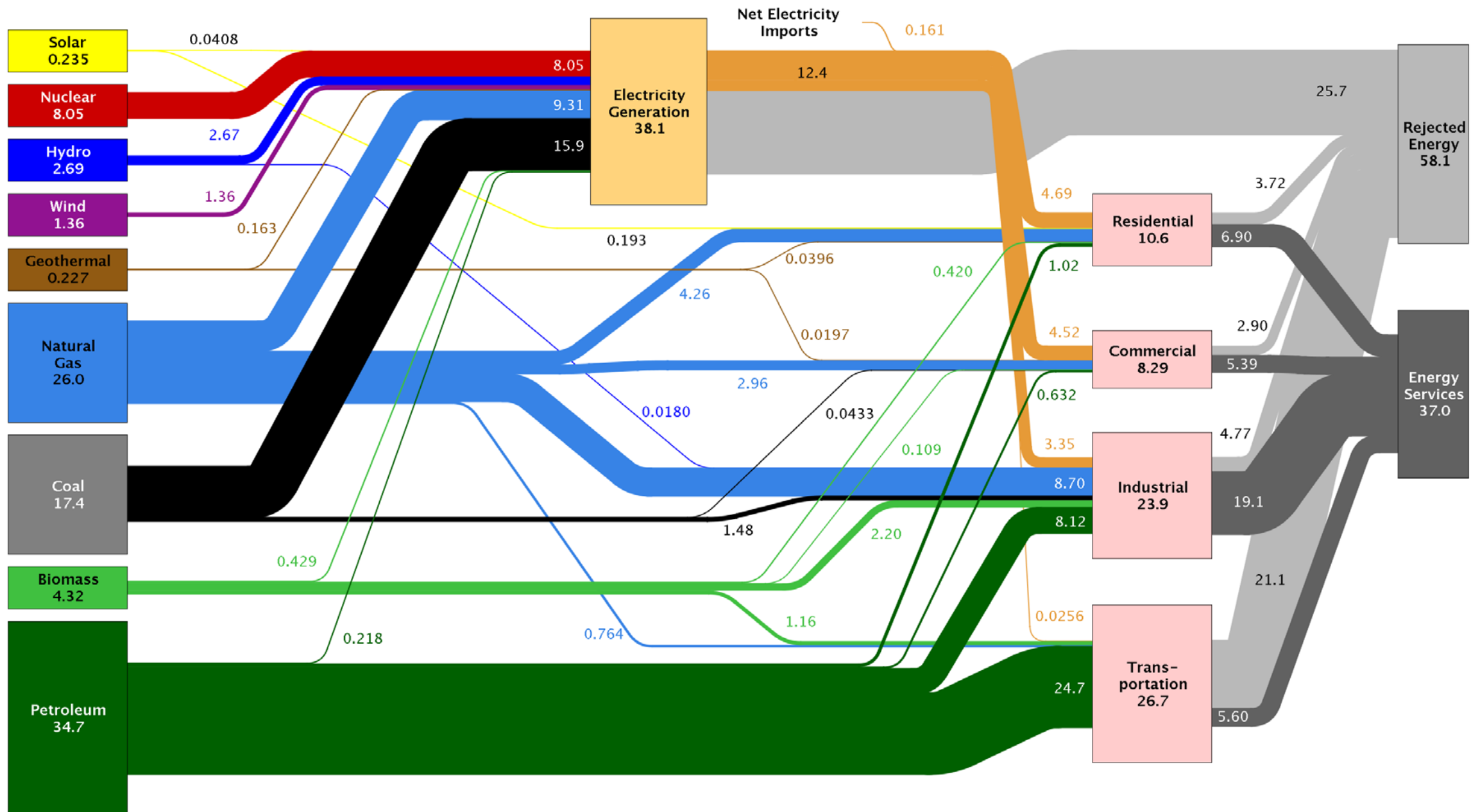


Click an icon to get more information about that system.



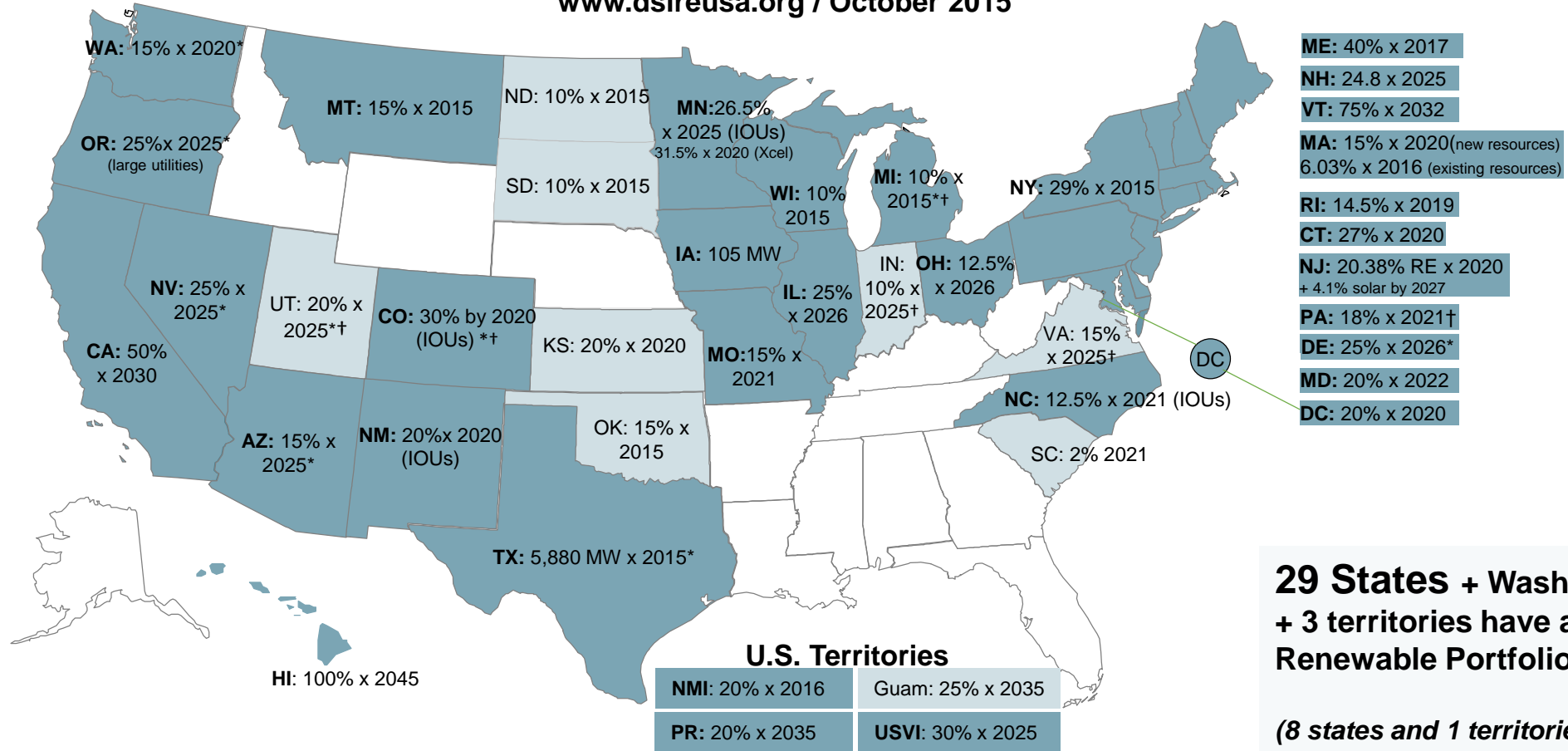
1.2 MW (utility-scale) PV power plant
“Solon 1” at UA Science and Tech Park

US Energy Use in 2012



Renewable Portfolio Standard Policies

www.dsireusa.org / October 2015



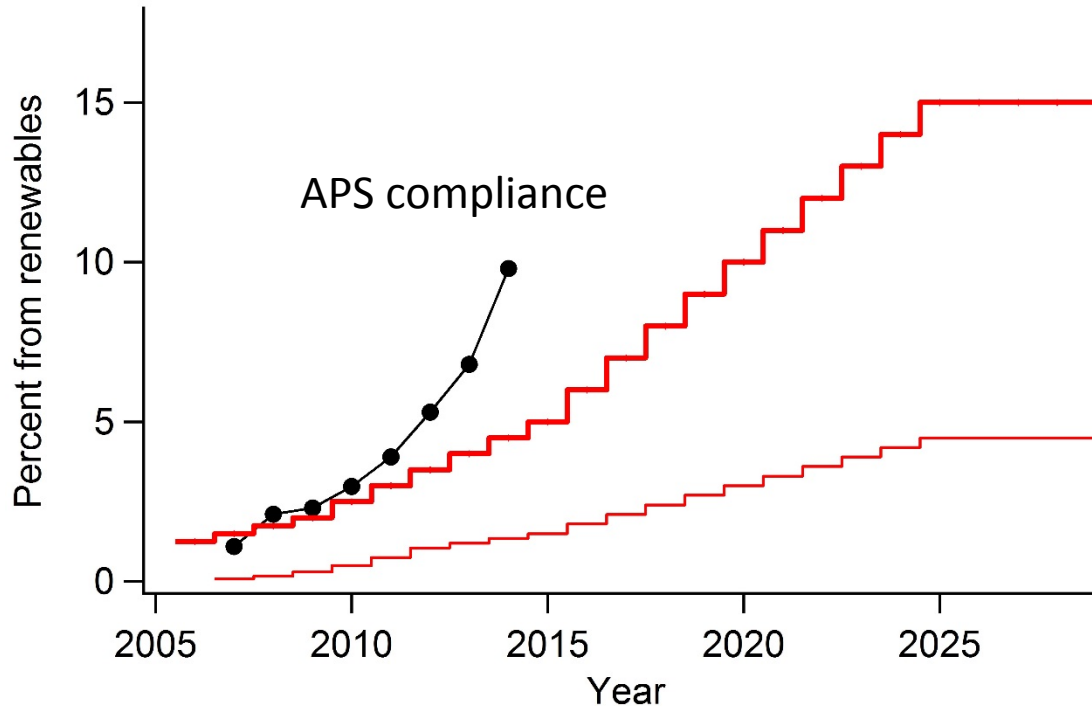
29 States + Washington DC + 3 territories have a Renewable Portfolio Standard

(8 states and 1 territories have renewable portfolio goals)

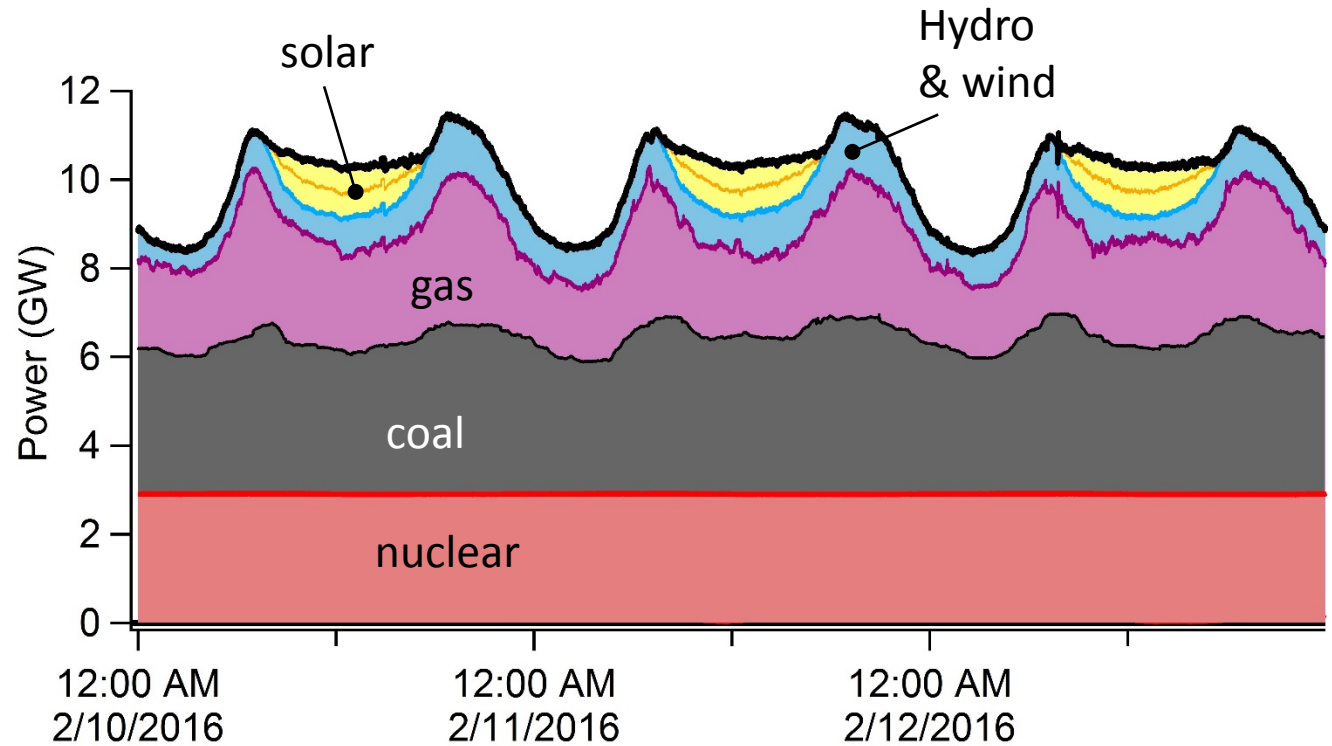
Renewable portfolio standard
 Renewable portfolio goal
* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources

AZ Renewable Portfolio Standard

Year by Year (15% x 2020)



Minute by Minute



REN
Renewable Energy Network

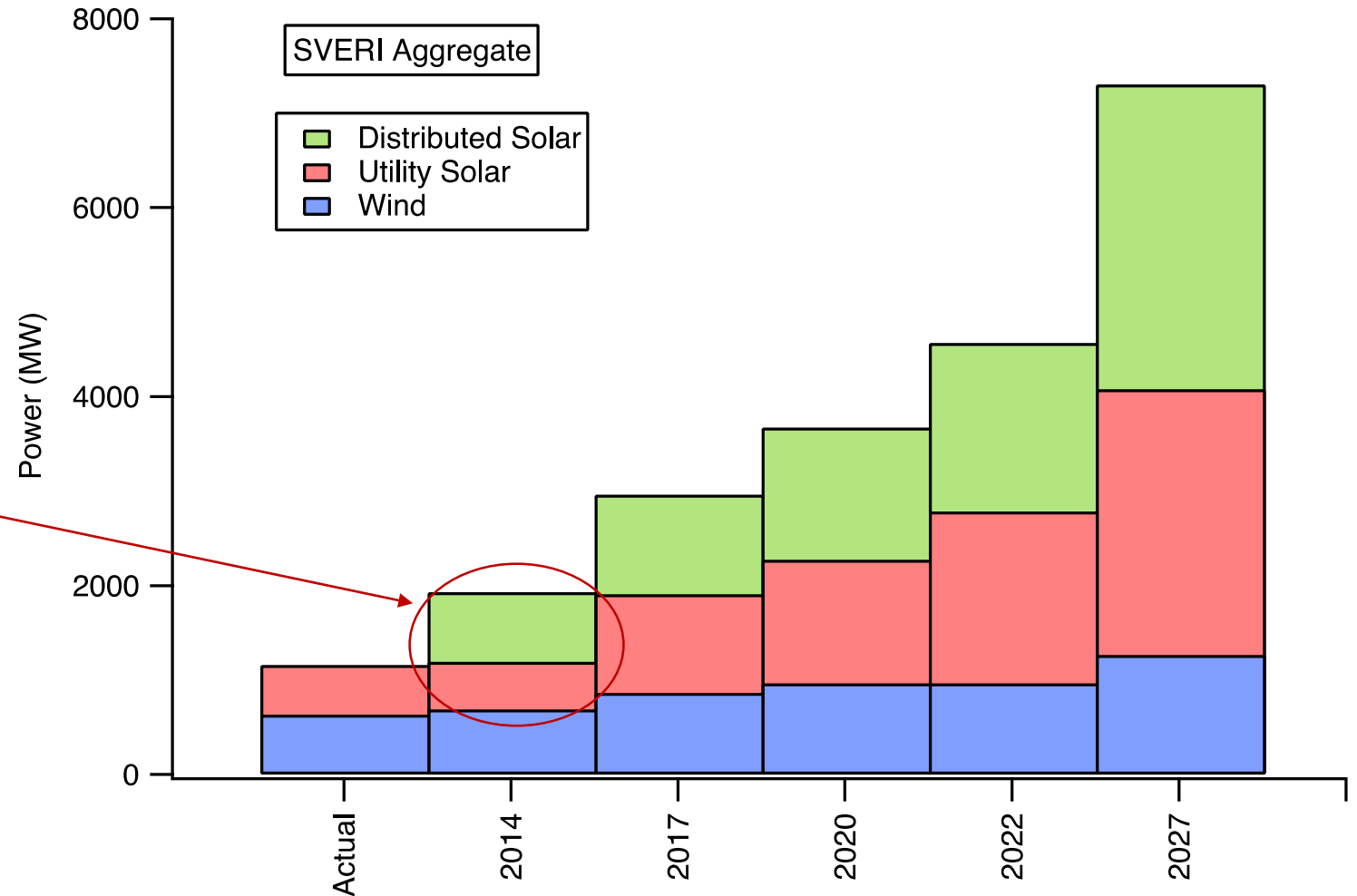
<https://sveri.uaren.org/>

Data From:

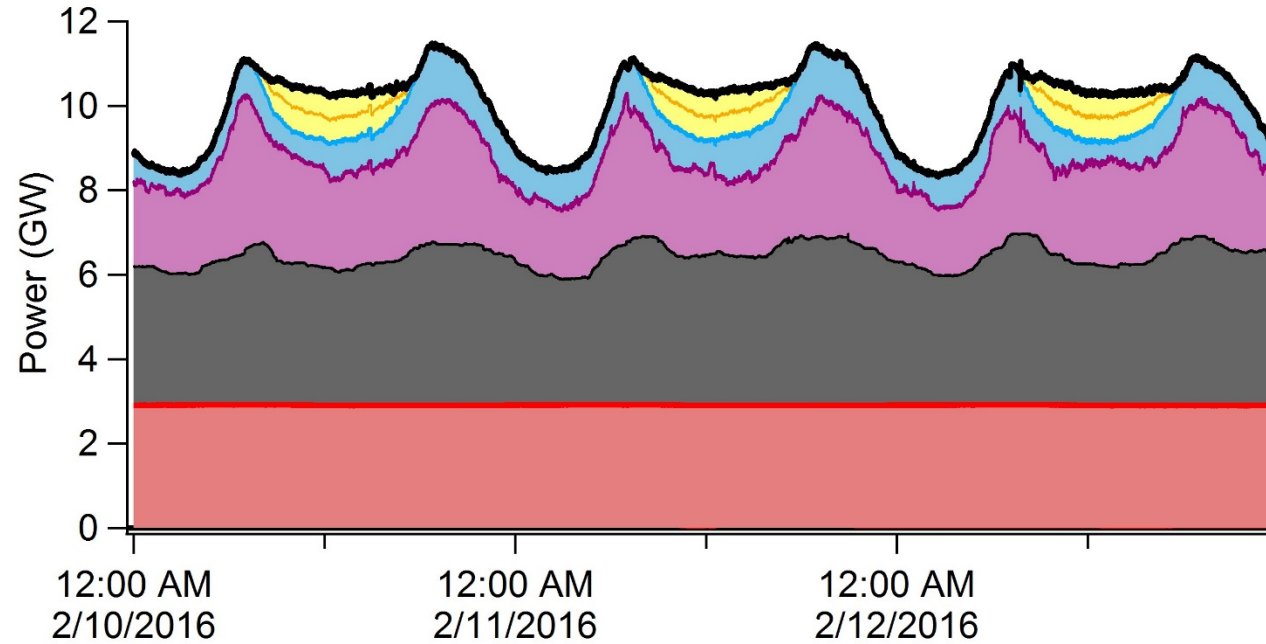


Projected growth in Wind and Solar for 8 utilities (TEP, APS, SRP, PNM, IID, WALC, EPE, AGT)

AZ + NM
have 1 GW
of solar power
already in 2014.

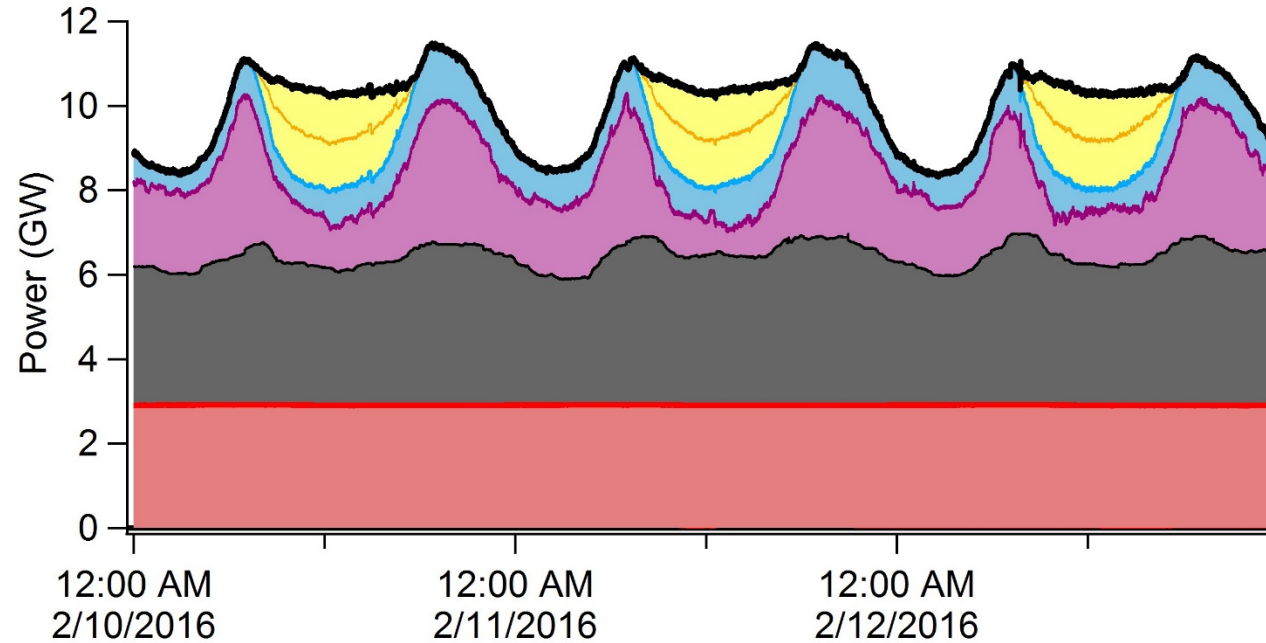


SVERI Scenario: 1x Solar (1.5 GW at noon) ~ 2016



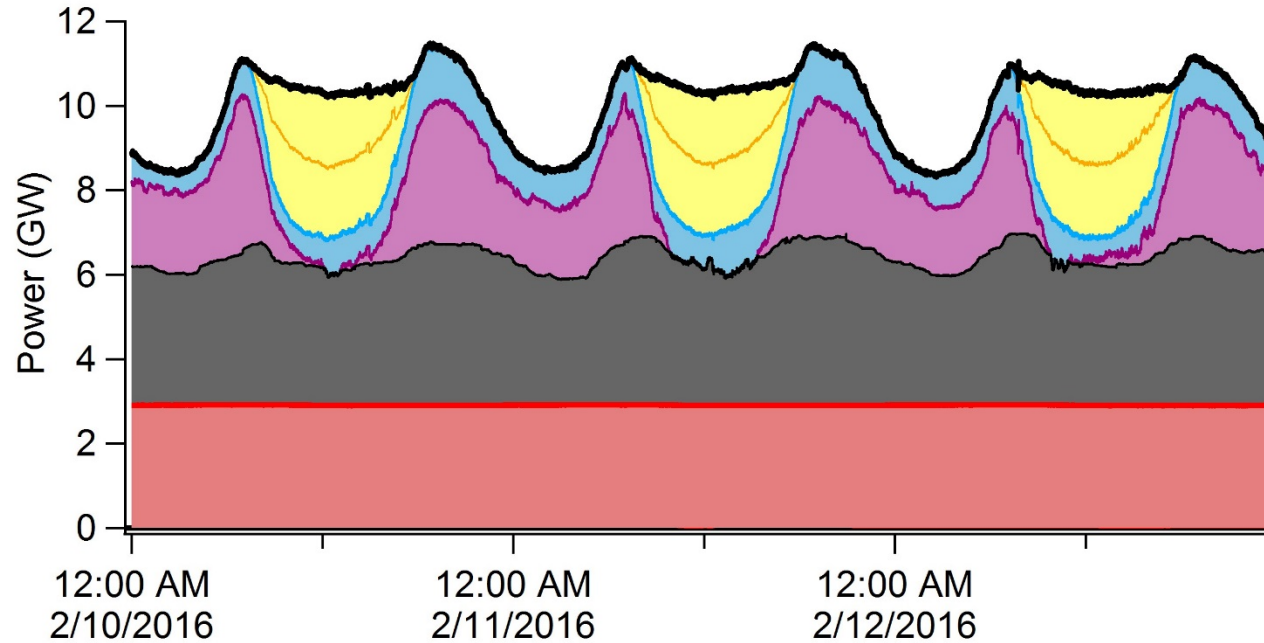
renewables / consumption: 12.5 %
renewables / sales: 12.7 %
solar / consumption: 3.6 %

SVERI Scenario: 2x Solar (3.0 GW at noon) ~ 2019



renewables / consumption: 16.2 %
renewables / sales: 16.7 %
solar / consumption: 7.3 %

SVERI Scenario: 3x Solar (4.5 GW at noon) ~ 2022



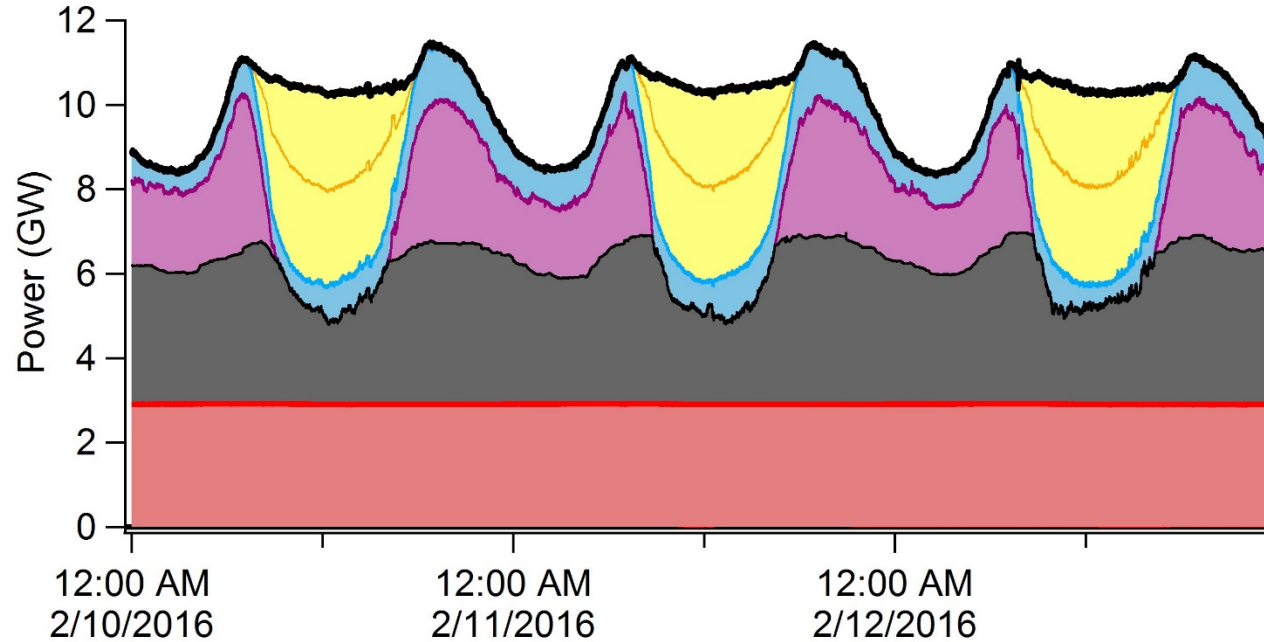
Unprecedented
dP/dt for gas

Need some

- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

renewables / consumption: 19.9 %
renewables / sales: 20.9 %
solar / consumption: 11.0 %

SVERI Scenario: 4x Solar (6.0 GW at noon) ~ 2025



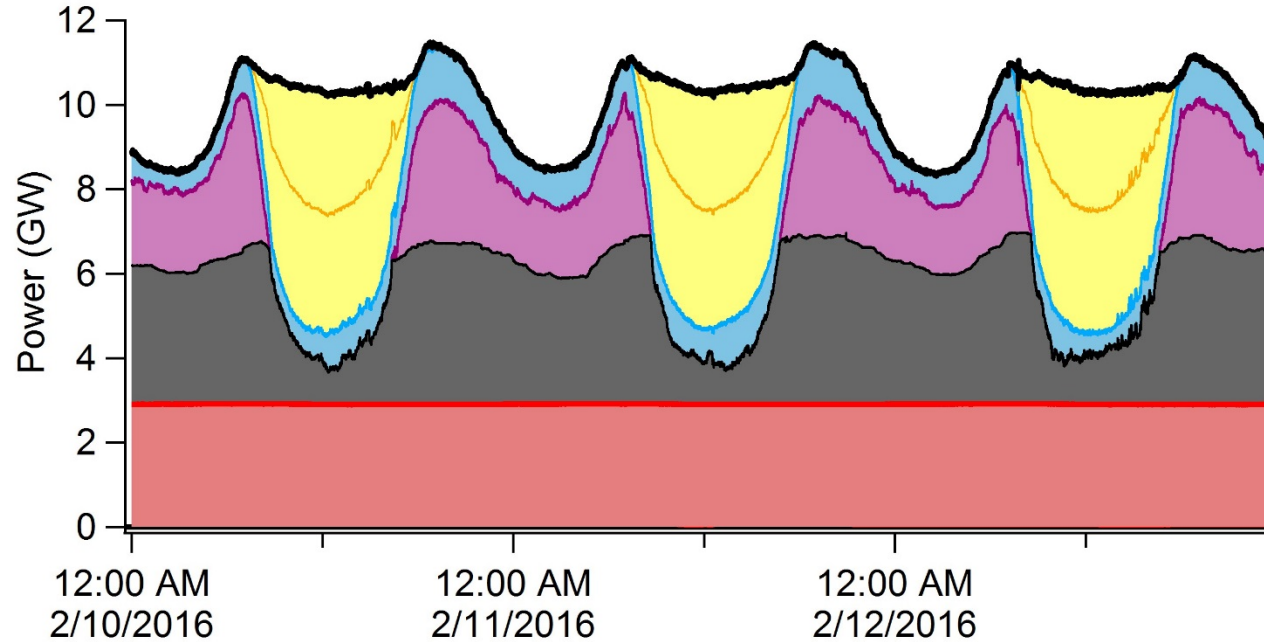
Impossible
 dP/dt for coal

Need some

- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

renewables / consumption: 23.6 %
renewables / sales: 25.2 %
solar / consumption: 14.7 %

SVERI Scenario: 5x Solar (7.5 GW at noon) ~ 2027



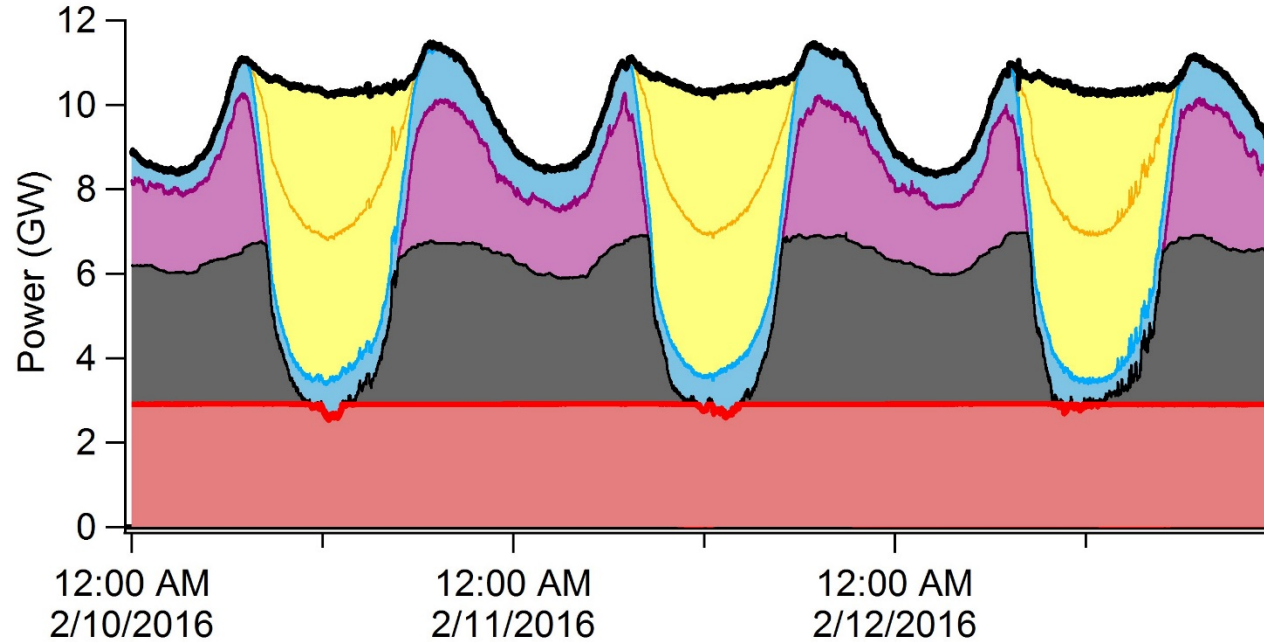
Impossible
dP/dt for coal

Need some

- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

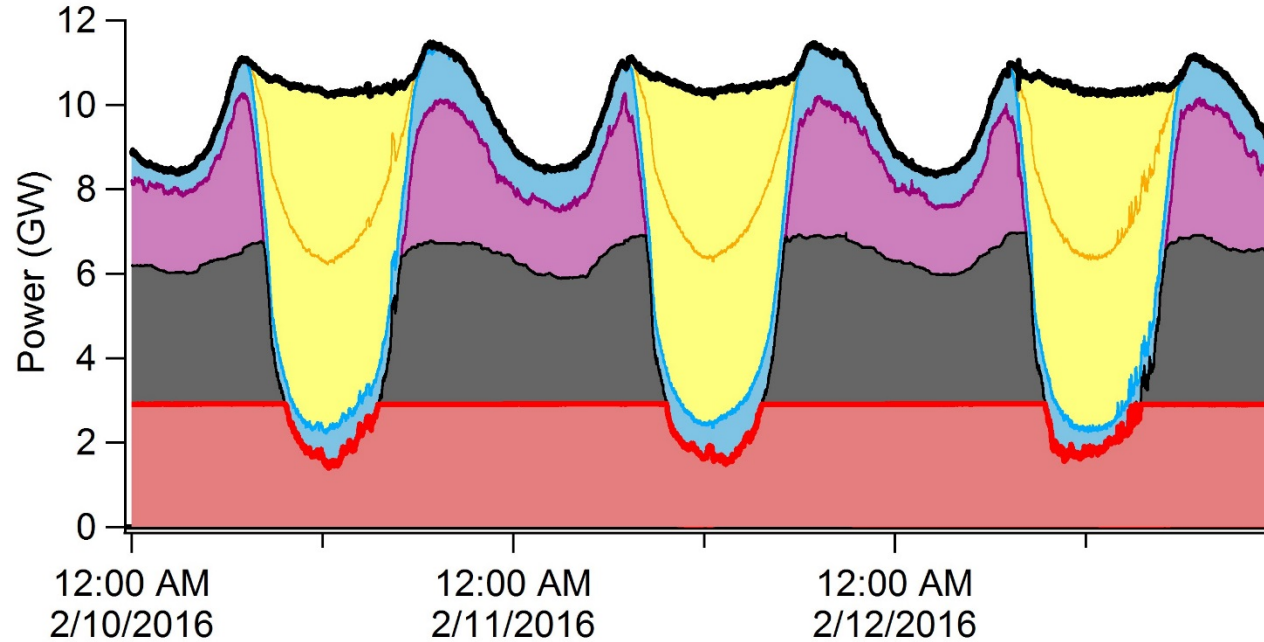
renewables / consumption: 27.3 %
renewables / sales: 29.7 %
solar / consumption: 18.4 %

SVERI Scenario: 6x Solar (9.0 GW at noon) ~ 2028



renewables / consumption: 30.9 %
renewables / sales: 34.3 %
solar / consumption: 22.1 %

SVERI Scenario: 7x Solar (11 GW at noon) ~ 2029



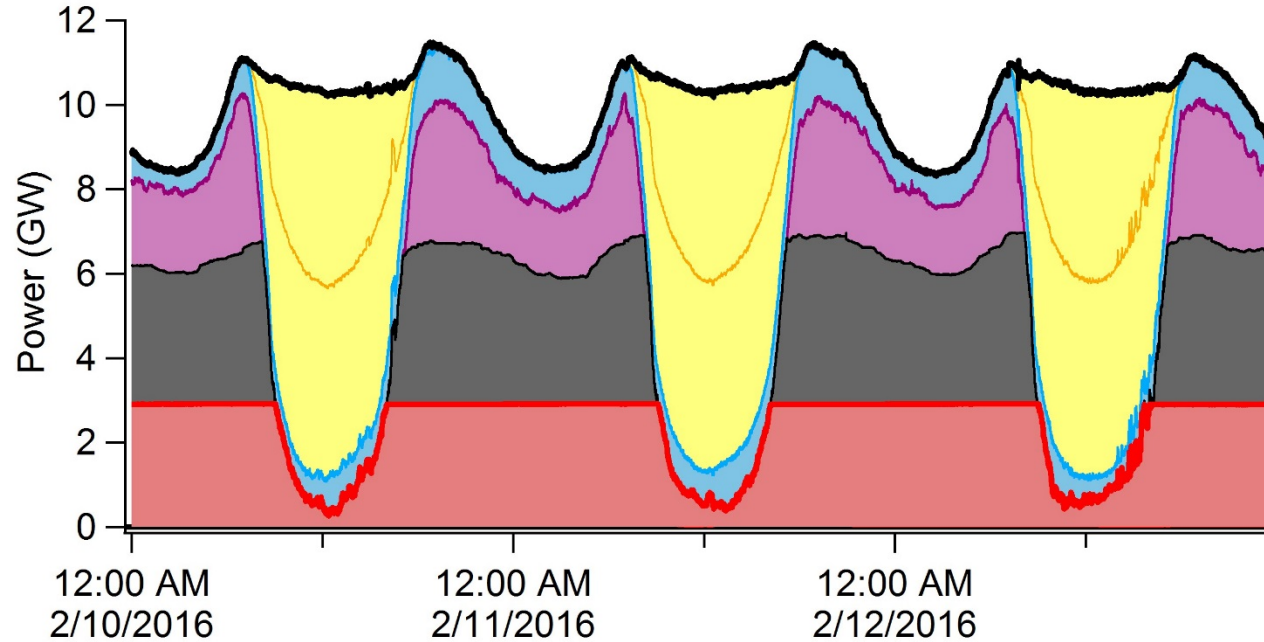
Impossible
 dP/dt for coal + nuc

Need some

- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

renewables / consumption: 34.6 %
renewables / sales: 39.1 %
solar / consumption: 25.7 %

SVERI Scenario: 8x Solar (12 GW at noon) ~ 2030



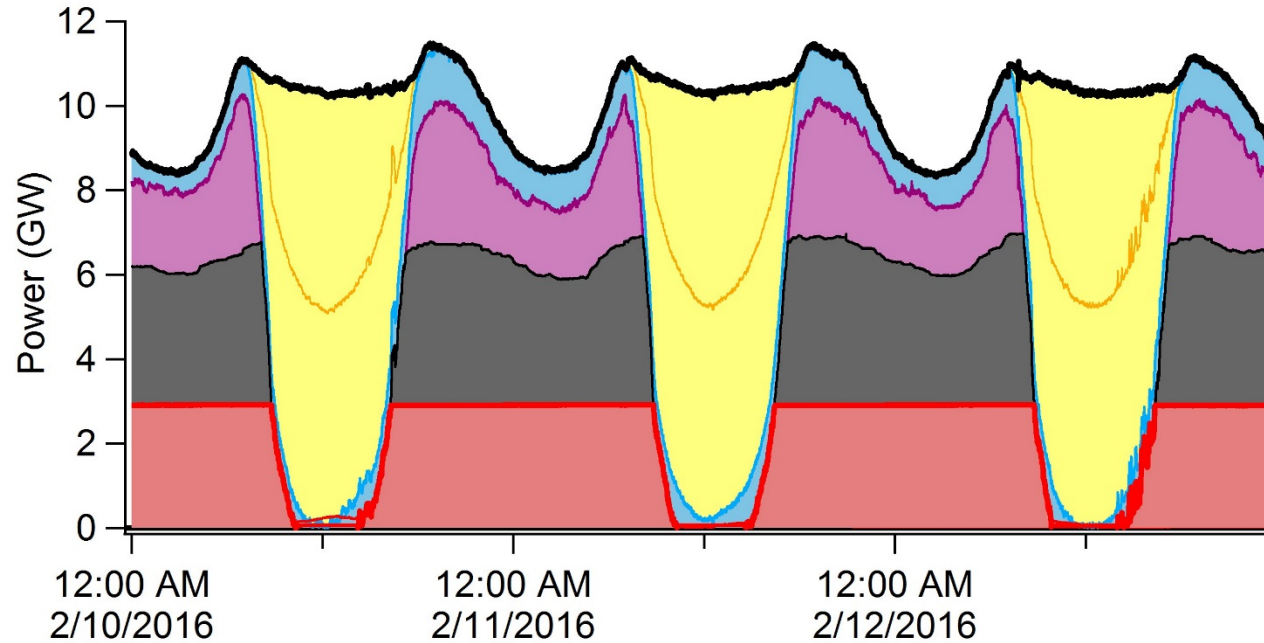
Impossible
 dP/dt for coal + nuc

Need some

- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

renewables / consumption: 38.3 %
renewables / sales: 44.0 %
solar / consumption: 29.4 %

SVERI Scenario: 9x Solar (14 GW at noon) ~ 2031



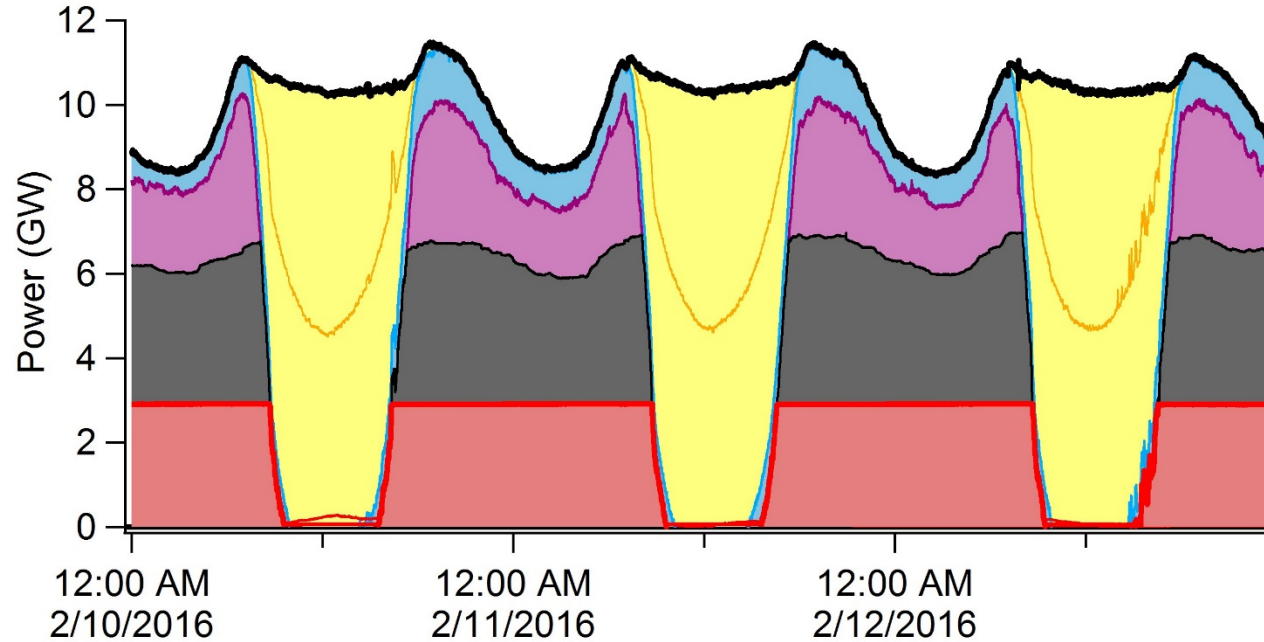
Impossible
 dP/dt for coal + nuc

Need some

- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

renewables / consumption: 42.0 %
renewables / sales: 49.2 %
solar / consumption: 33.1 %

SVERI Scenario: 10x Solar (15 GW at noon) ~ 2032



Impossible
 dP/dt for coal + nuc

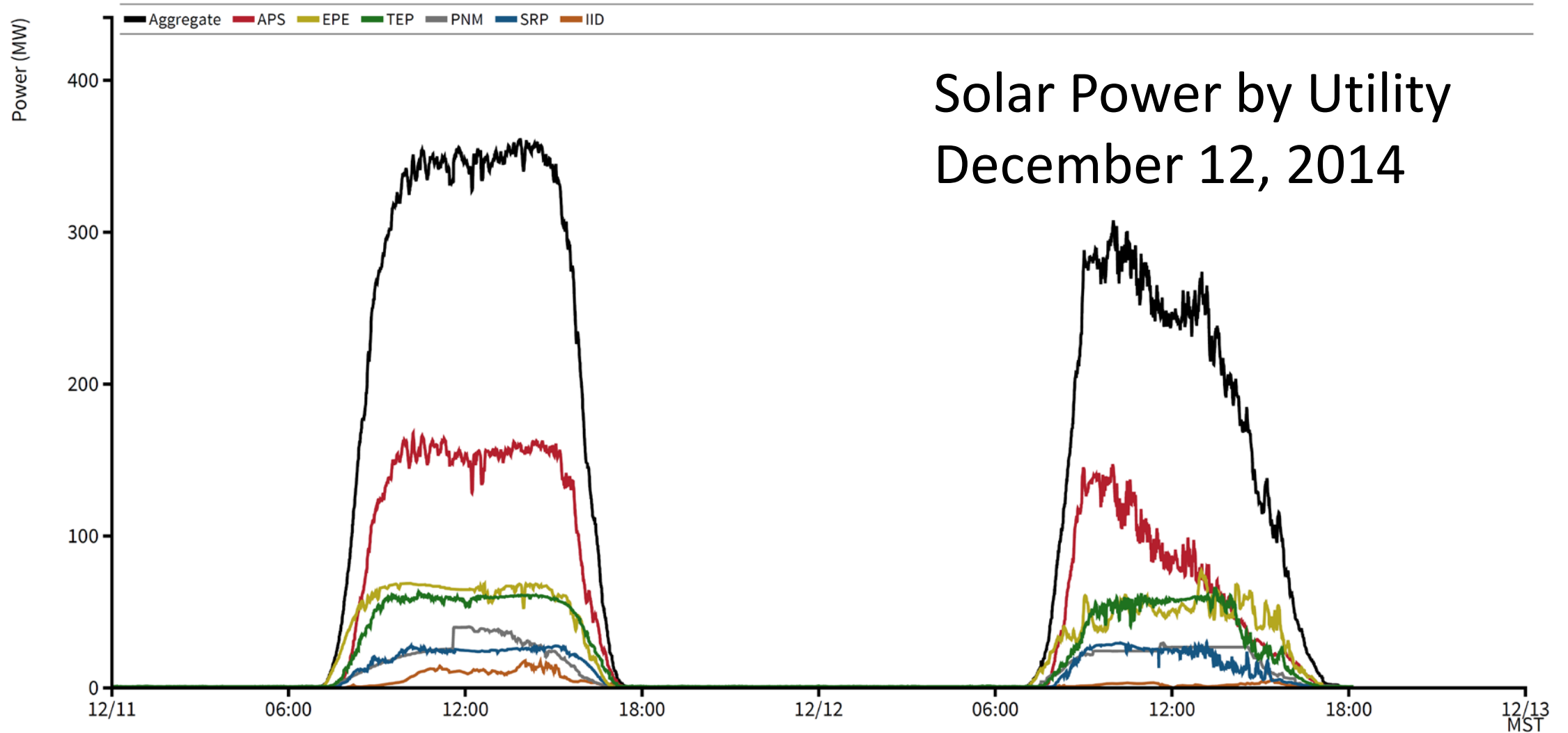
Need some

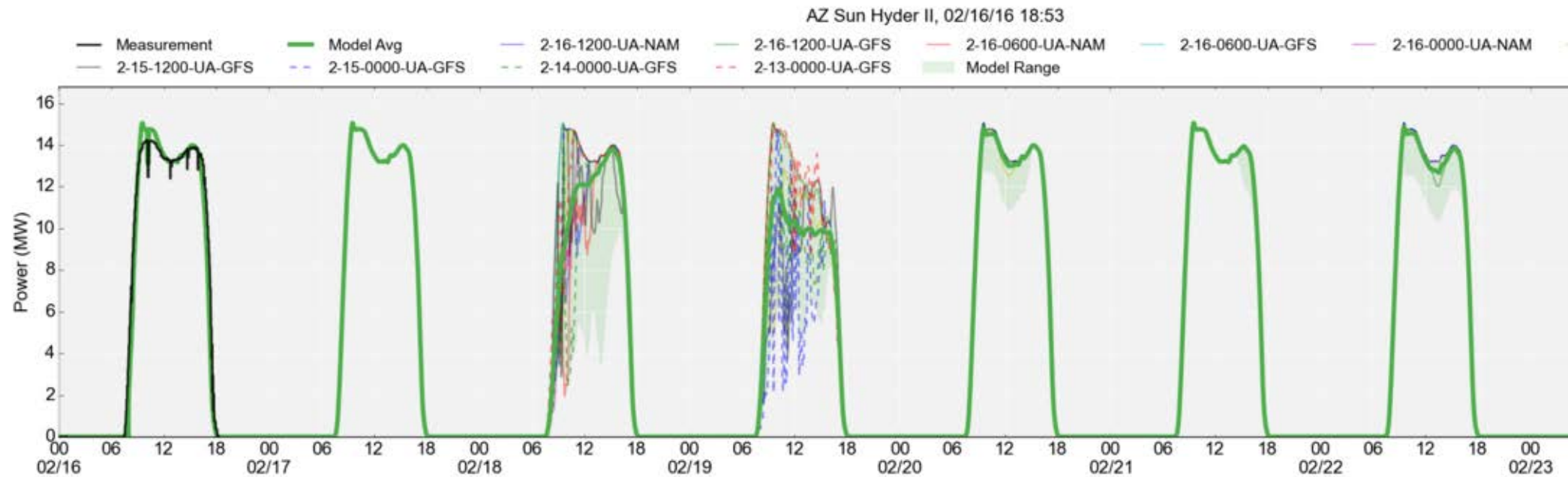
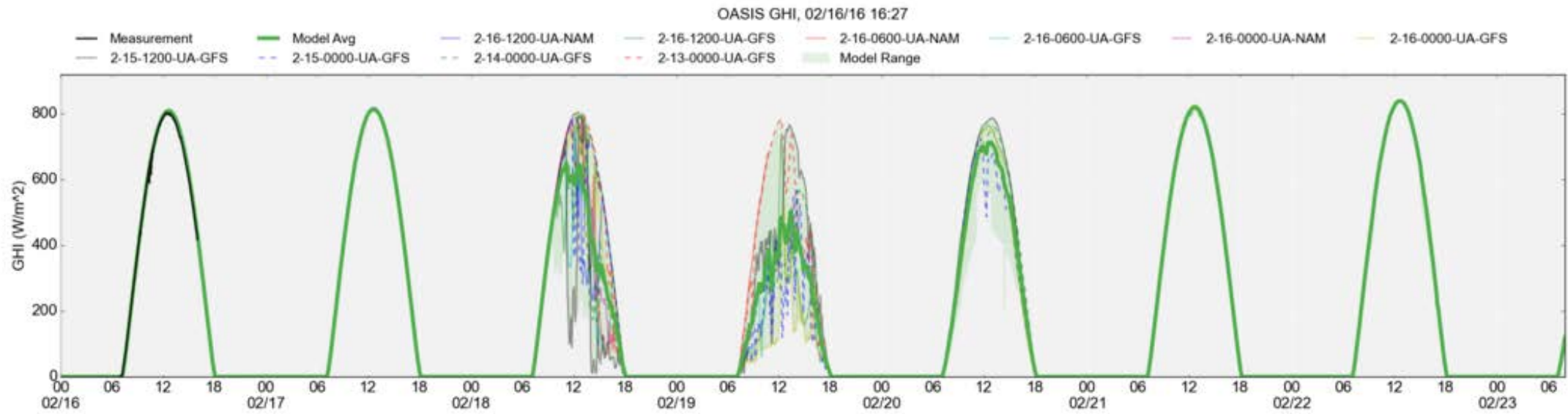
- curtailment
- energy storage
- load shifting
- power forecasts
- energy trading
- flex. reserves

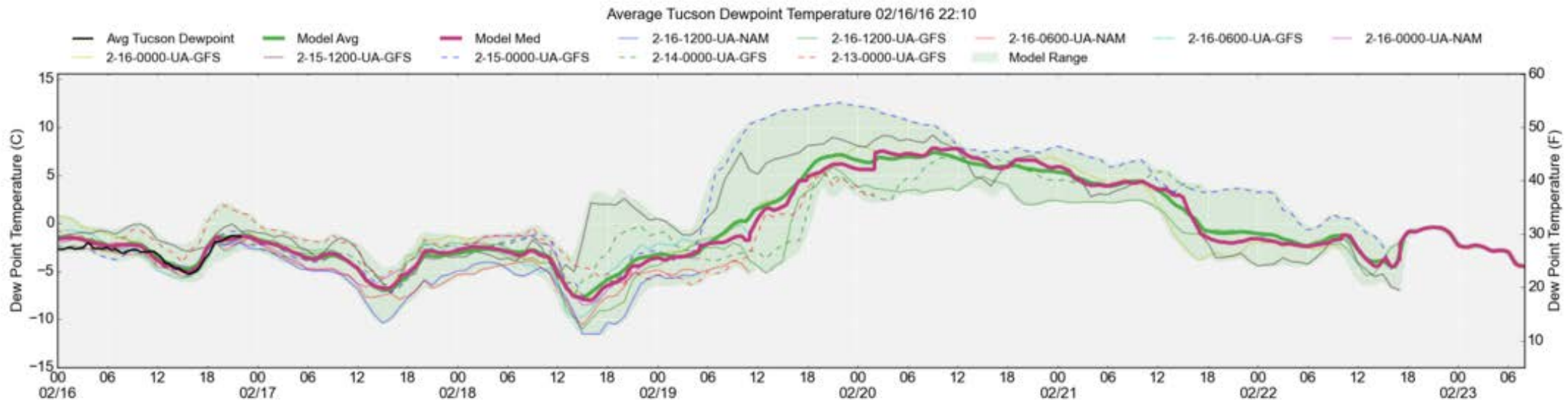
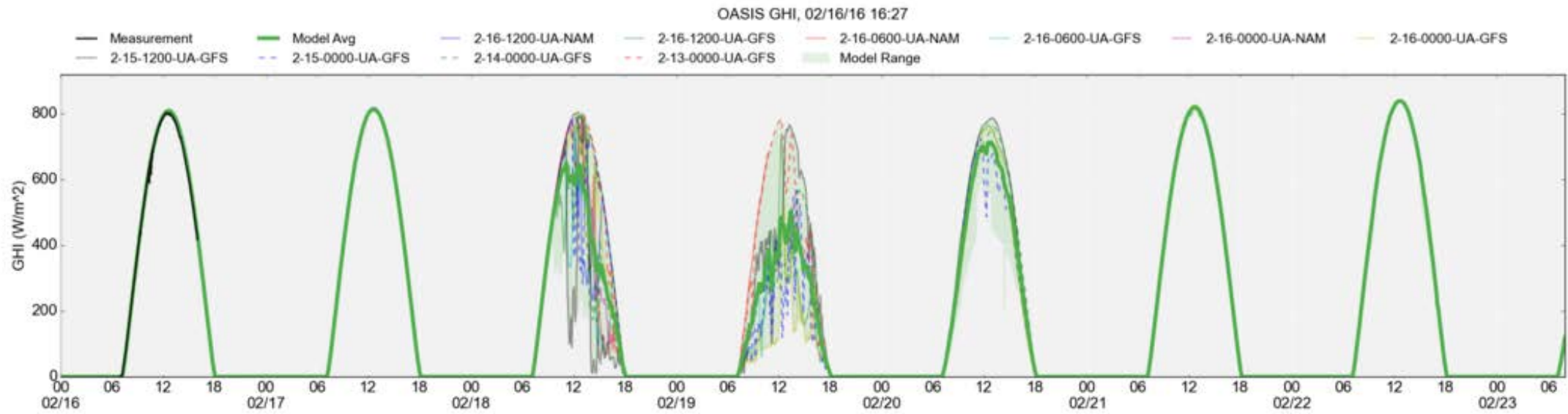
renewables / consumption: 45.7 %
renewables / sales: 54.5 %
solar / consumption : 36.8 %

Utilities want forecasts for variable output

Solar










Solar Policy Issues relevant to the Food/Energy/Water Nexus

- Renewable Energy Standards (RES)
- Investment Tax Credit (ITC)
- Land Use

- Geographic diversity of power plants helps utilities
- Energy Markets / Transmission / Reserve Sharing Groups
- Energy Storage Mandates / Curtailment Strategies

- Demand Management (Load Shifting) \leftrightarrow Water / Ag. / Mining
- Forecasting Power Production \rightarrow decision support for Util. / Ag.

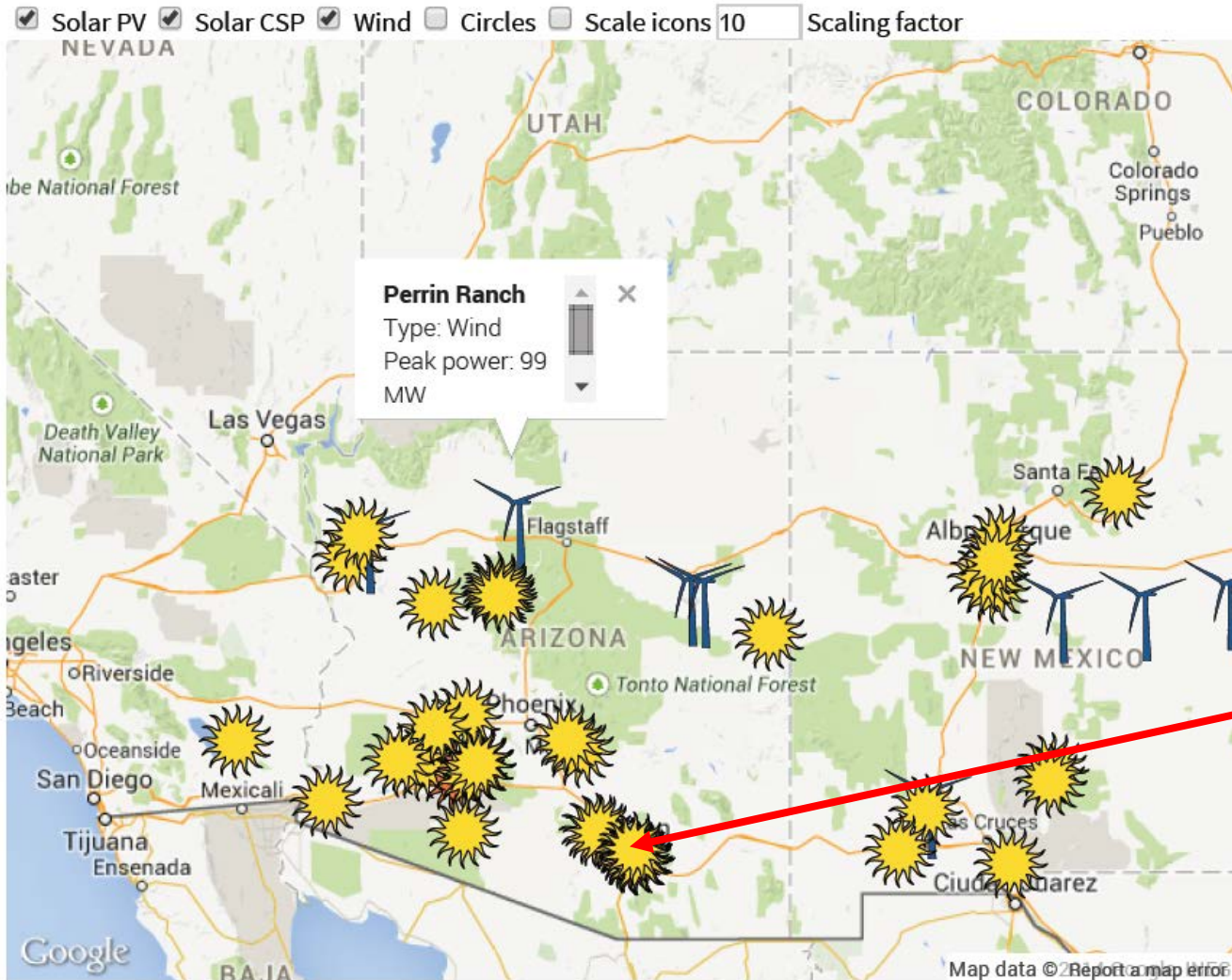
Issue:	Smog	Acid Rain	Ozone Hole	Global Warming
Substance:	VOC, NOx PM10, CO	SOx, NOx	CFC's	CO2, CH4
Mitigations:	Catalytic conv., Electro-precip.	Wet scrubbers (calcium rich)	Alternate refrigerants	Burn less coal/gas (?) sequester CO ₂ (?)
Public Policies:	Clean Air Act 1967, 1970, ... 	Helsinki Protocol 1985, Oslo 1994, cap+trade 2005 	Montreal Protocol 1987 	Kyoto 1992 (x) Copenhagen 2009 (x) Paris 2016 (?) Clean Power Plan (?) Efficiency (✓) Renewable Energy Standards Investment Tax Credit '08, '15 DOE SunShot, EERE Energy Storage Mandates Demand Management Energy Markets/ Transmission Forecasting

Science, Engineering, Economics, Law
Research & Development enable Policy.

Alex Cronin, UA Professor of Physics

Discuss: Solar, the FEW Nexus, and Policy

<https://sveri.uaren.org/>
<https://forecasting.uaren.org/>



Click an icon to get more information about that system.



1.2 MW (utility-scale) PV power plant
“Solon 1” at UA Science and Tech Park

Thanks!