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Looking Beyond the Hour

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ACEEE Energy Efficiency as a Resource Conference

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Outline

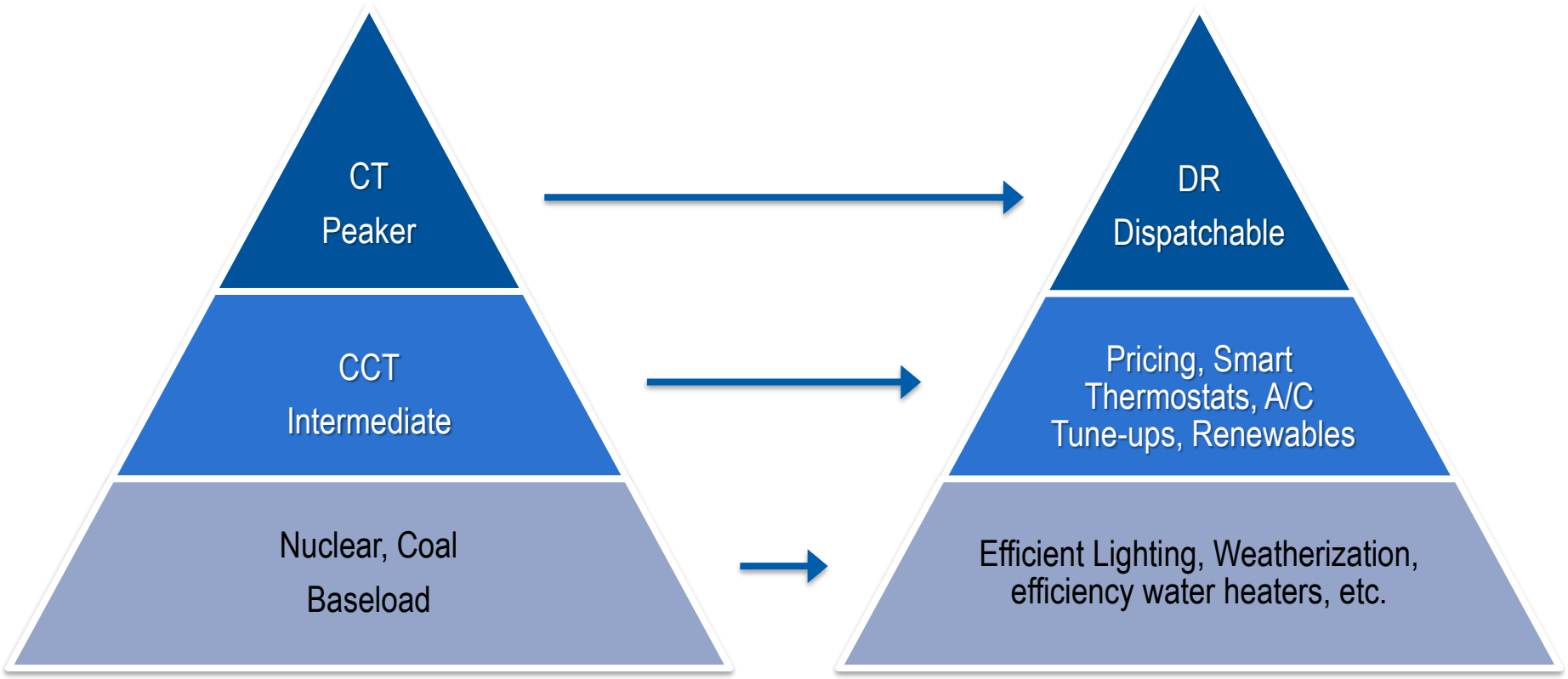
Role of EE in Power System Planning

System Benefits of EE

Measuring and valuing capacity contributions

Remembering Arthur Rosenfeld

DSM, the Virtual Power Plant



Conventional Generation

Demand-Side Management

Energy Efficiency – A Layered Cake

Avoided Externalities

Ancillary Services

T&D System

Capacity

Energy

Capturing Capacity Value of Energy Efficiency

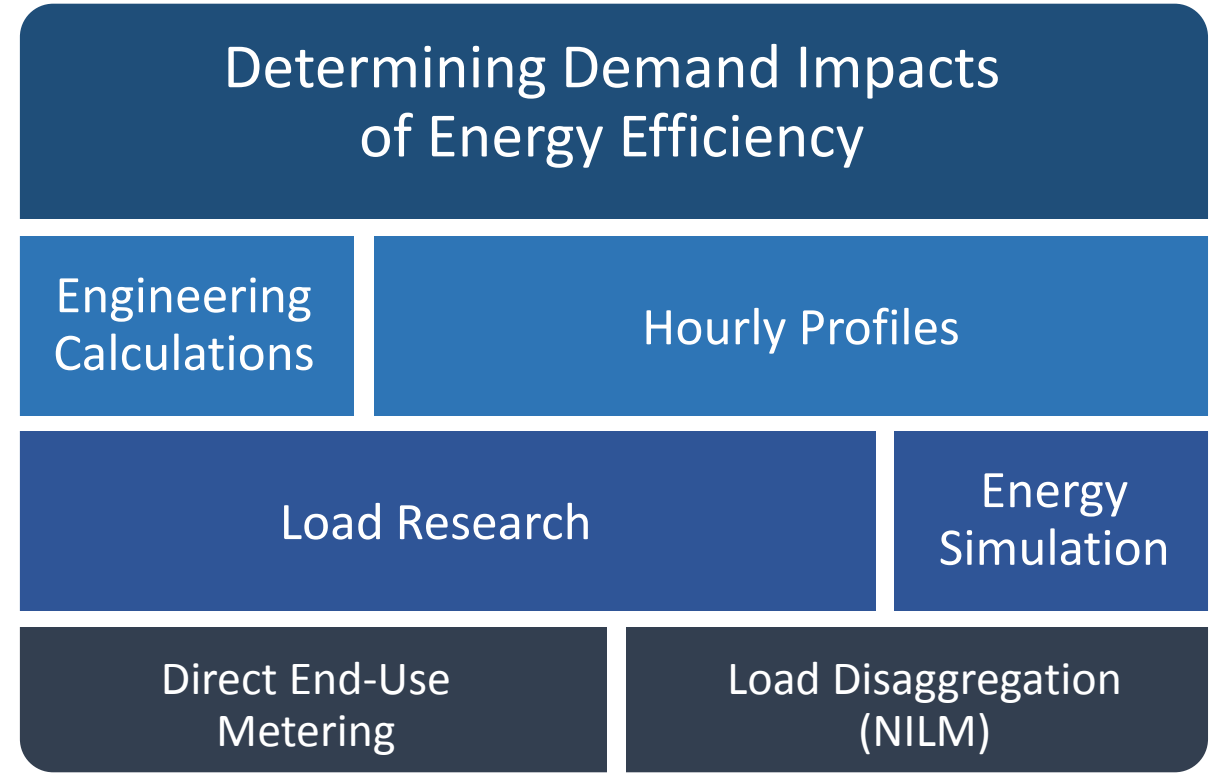
What is needed:

- Hourly system load profile
- Hourly energy efficiency measure "savings" profile
- Avoided hourly energy cost ($/MWh)
- Avoided capacity costs ($/kW-year)

What to do:

- Define peak hours (window)
- Calculate capacity value as product of load shape and avoided costs
- Calculate levelized benefits over measure's EUL

Where Load Shapes Come From



Defining Peak

Highest peak (1) hour

Highest consecutive hours

Top hours of load duration curve (top 2%-5%)

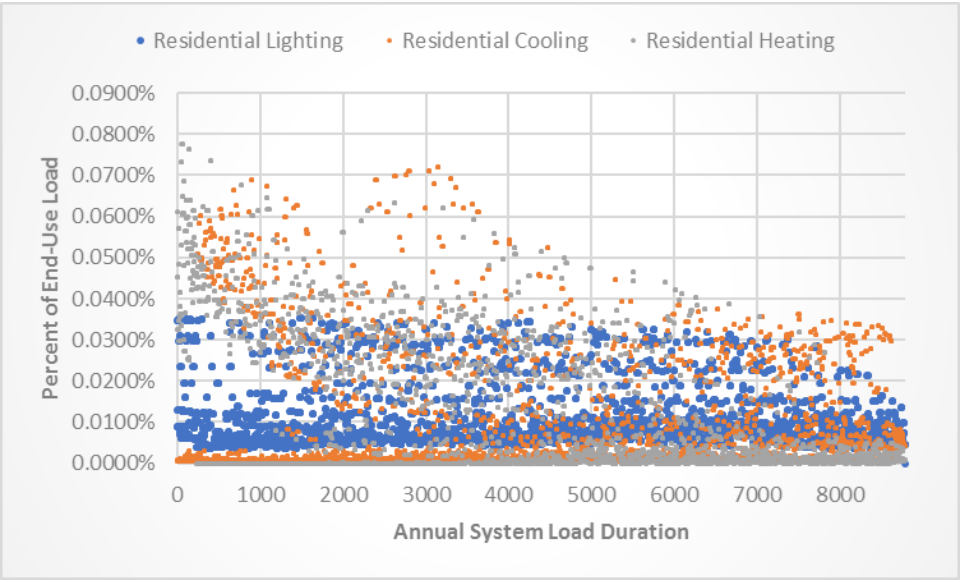
Daily peak hours (e.g. 3:00 – 8:00) weekdays in January and February

Loss of load probability (LOLP)

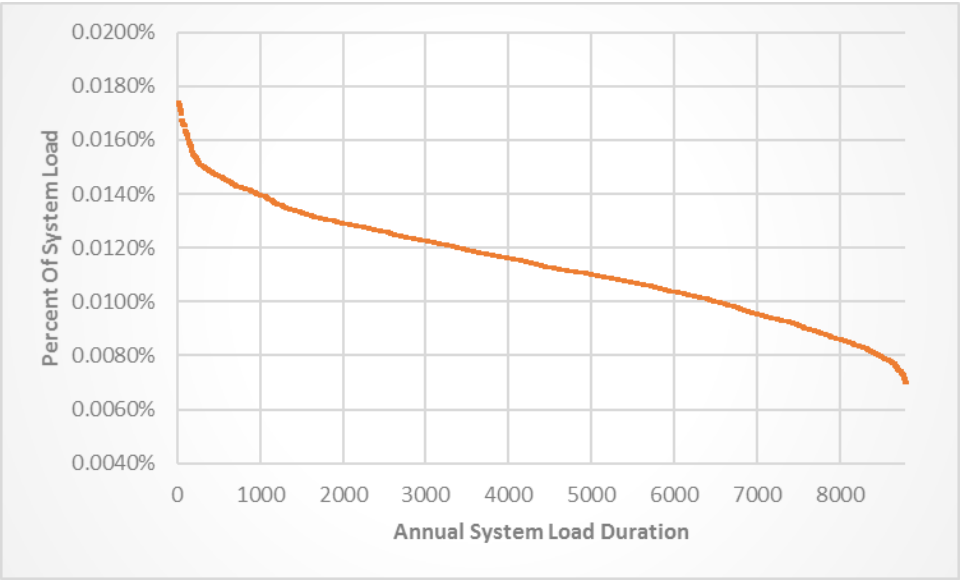
Hourly peak probability distribution

Example: Residential Sector Winter Peaking Utility

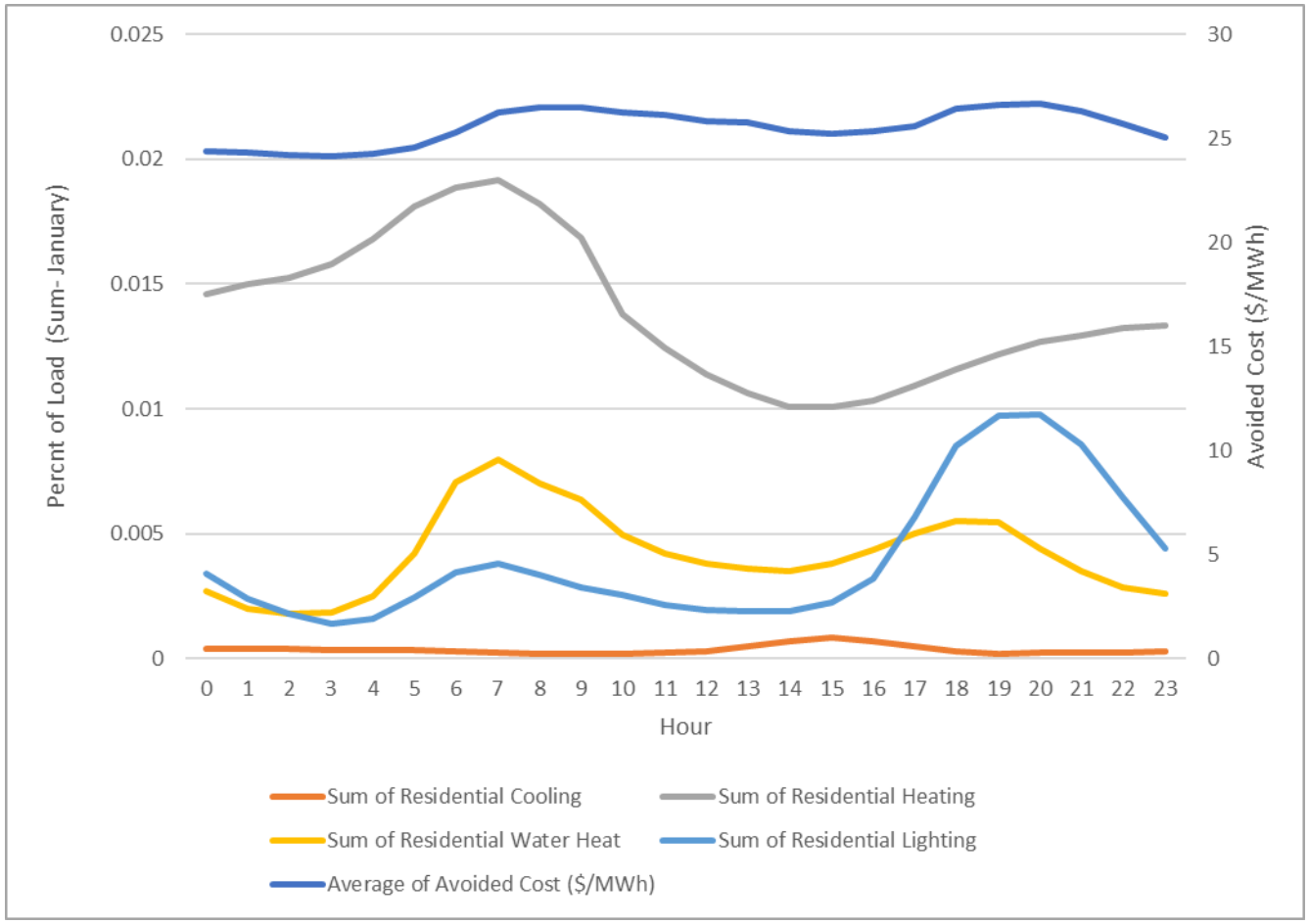
Hourly End-Use Loads



Hourly System Load



Example: Residential Sector (Winter Month)



How We Define Peak Matters

Avoided Cost Value Captured by Measures

	Peak Hour	Top Twenty Hours	Peak Period
No Capacity Value			
Residential Lighting	$3.59	$5.66	$4.05
Residential Cooling	$0.21	$0.00	$0.33
Residential Heating	$16.98	$12.86	$11.58
With Capacity ($100/kW)			
Residential Lighting	$16.48	$25.76	$19.26
Residential Cooling	$0.96	$0.00	$1.57
Residential Heating	$78.06	$59.01	$55.27

Conservation Load-Factor

Conservation load factor:

$$CLF = \frac{\text{Average Annual Hourly Load Savings (kW)}}{\text{Peak Load Savings (kW)}}$$

Or:

$$CLF = \frac{\text{Annual Energy Savings (kWh)}}{\text{Peak Load Savings (kW)} * 8760}$$

1. Elegant concept
2. Easy to calculate
3. Analogous to system load factor (LF), capacity utilization factor (CUF), and diversity load factor (DLF)

Conservation Load-Factor

Conservation load factor:

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Or:

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Heating (HP):

- Annual savings (kWh) = 457
- Peak hour savings (kW) = 0.28
- CLF = 0.19

Lighting (LED):

- Annual savings (kWh) = 40
- Peak load savings (kW) = 0.01
- CLF = 0.41

Conservation Load-Factor - Example

Assume a residential lighting and A/C efficiency program with savings of 10% in lighting and 10% in A/C usage annually:

Heating (HP):

- Annual savings (kWh) = 457
- Peak hour savings (kW) = 0.28
- CLF = 0.19

Lighting (LED):

- Annual savings (kWh) = 40
- Peak load savings (kW) = 0.01
- CLF = 0.41

Valuation of Capacity Savings

Recall that:

$$\text{CLF} = \frac{\text{Annual Energy Savings (kWh)}}{\text{Peak Load Savings (kW)} * 8760}$$

Or:

$$\text{CLF} * 8760 = \frac{\text{kWh}}{\text{Peak kW}}$$

Assume capacity value of $60 per kW-year

- Capacity value of 1 kW of savings from heating
  = $60 ÷ (0.19 * 8760) = 4.0 cents
- Capacity value of 1 kW of savings from lighting
  = $60 ÷ (0.41 * 8760) = 2.0 cents

The lower the CLF, the higher the capacity value from a kWh saved.

ANY

QUESTIONS

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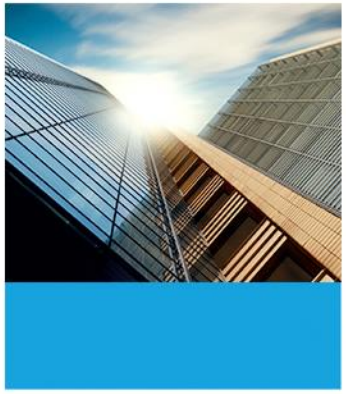

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