Enhancing Demand Response in Liberalised Electricity Markets

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The Kyoto context: measuring and evaluating the energy efficiency and emissions reduction potential from DR programs

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(*) This is not an official document of the Italian Regulatory Authority for Electricity and Gas

Autorità per l'energia elettrica e il gas

The issue - 1

Reliability

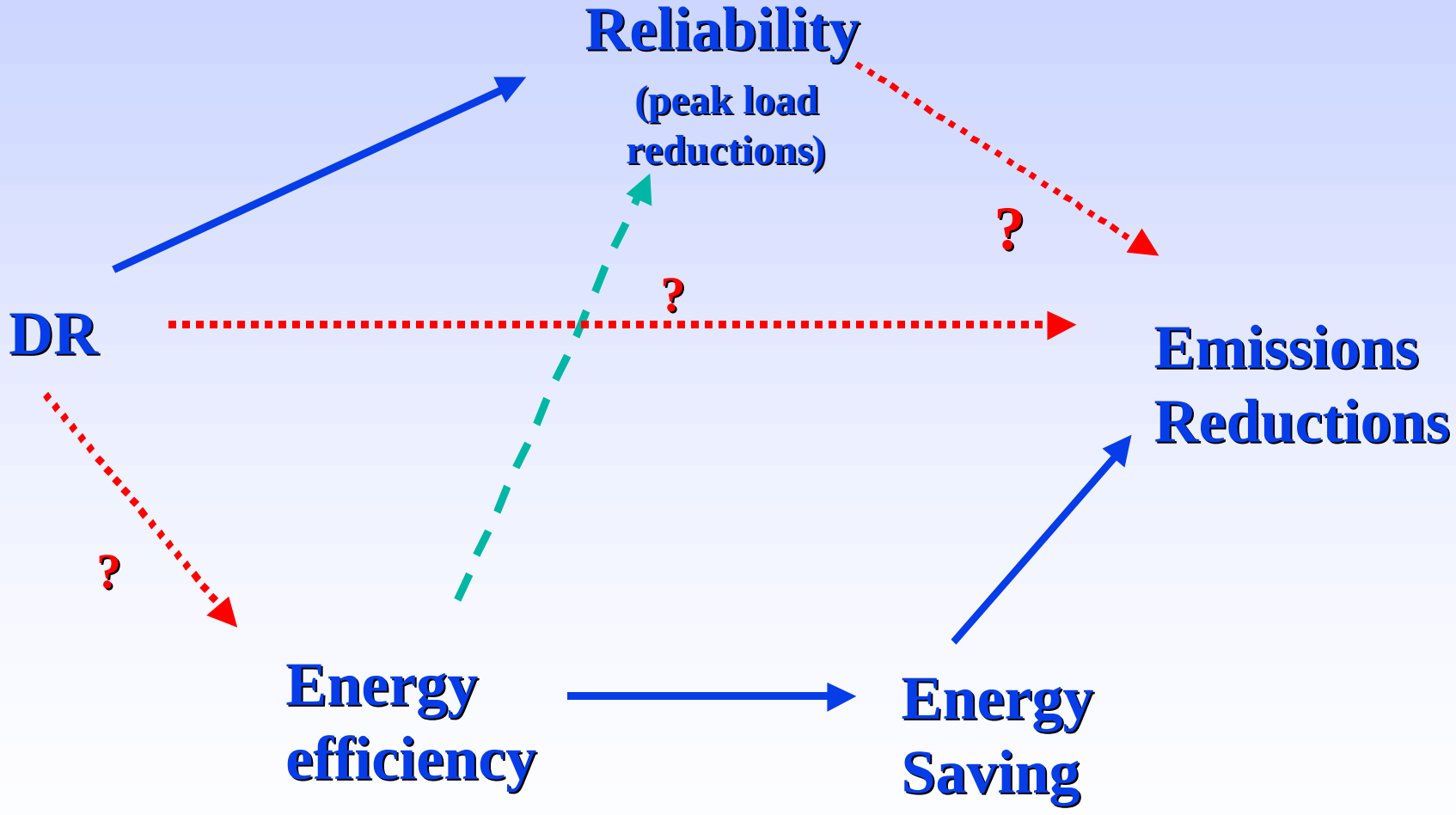
DR

Emissions reductions

Energy Efficiency

Energy savings

The issue - 2


Reliability
(peak load reductions)
?
?
DR
?
Emissions Reductions
Energy efficiency
Energy Saving

A challenging question: why - 1

- Generally **you do not want to measure these impacts** because the pursued aims and benefits of DR programs are different:
  - there are **crucial differences** between energy efficiency (EE) and DR programs which explain why DR should not be expected to give all the benefits that EE can provide (e.g., particularly energy savings and environmental improvement)
  - **the more fundamental difference is that the objective of DR is peak demand** and peak demand is not expected to have much effect on energy efficiency and emissions.

A challenging question: why - 2

- The evaluation of the energy savings and emissions reduction impact of DR poses **methodological questions that are specific** to DR programs and are normally not addressed when you evaluate these impacts for EE programs

Definitions

- **Energy efficiency:**

  includes measures which result in producing the same or better levels of amenities (e.g. lighting, space conditioning, motor drive power, etc.) using less energy; measures are generally long lasting and save energy across different time periods

- **Demand Response:**

  seeks to lower peak demand during specific, limited time periods, by temporally curtailing electricity usage or shifting usage to other time periods

How do DR and EE compare - 1

- **DR reduces peak demand in specific, limited time periods** and generally **does not result in energy savings because it does not address the barriers** to the development of a market for energy efficiency products and services

… while …

EE can reduce load significantly, the load reductions occur **over many hours** of the load shape and **for many days** of the year, thereby **saving energy as well as reducing peak demand**

How do DR and EE compare - 2

- **Barriers** to the development of a market for energy efficiency products and services:
  - **market barriers, e.g.:**
    - ✓ lack of information
    - ✓ performance uncertainties
    - ✓ market response uncertainties
    - ✓ high transaction costs
    - ✓ asymmetric information
    - ✓ limited access to financing
    - ✓ splits incentives
  - **institutional barriers, e.g.:**
    - ✓ public nature of some EE benefits versus private nature of customer investments
    - ✓ time and nature of EE investments versus the benefit stream
    - ✓ market development as a short term commodity and price focus versus a longer term resources and value focus

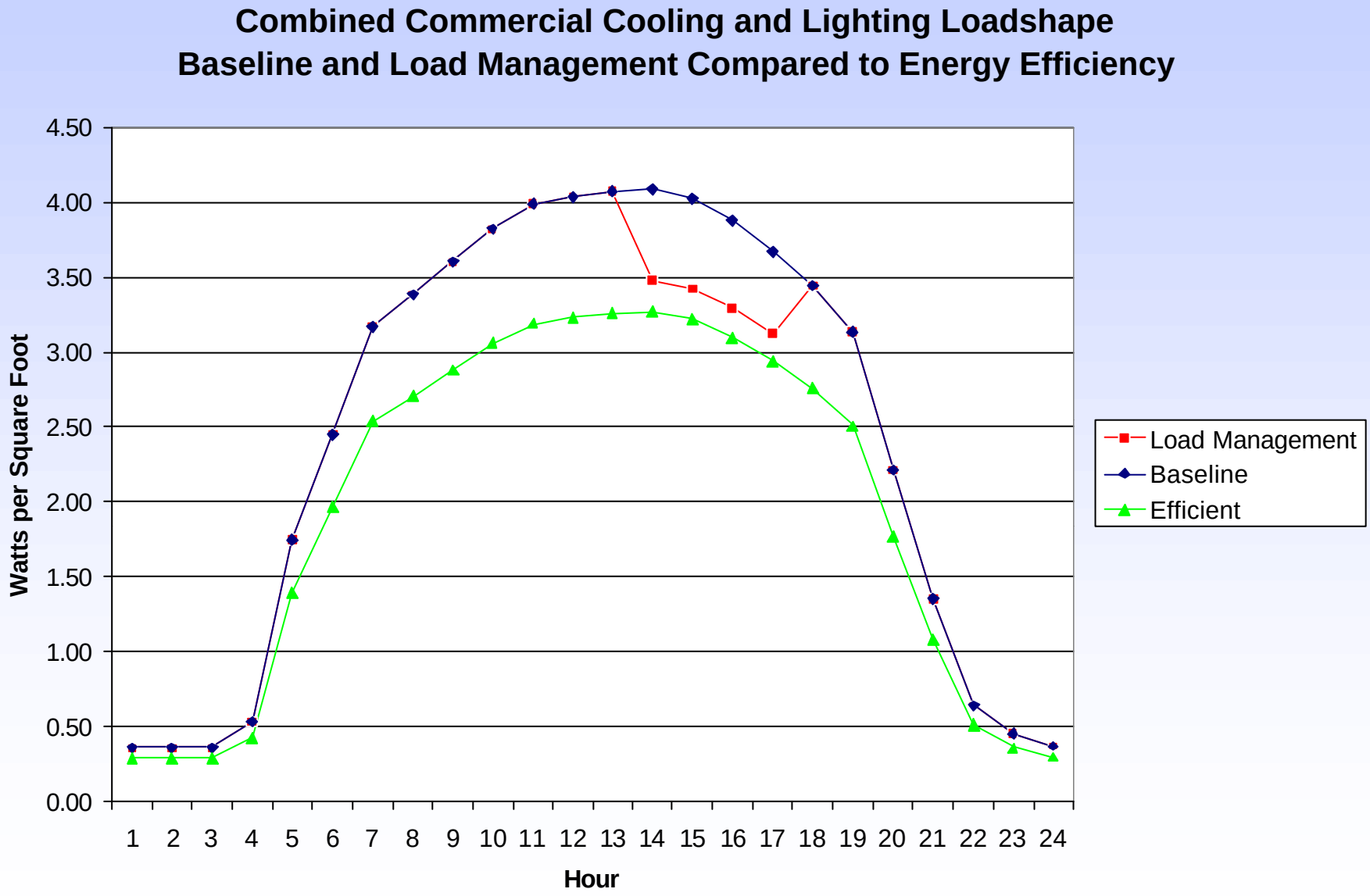
How do DR and EE compare - 3

(DR reduces peak demand in specific, limited time periods and generally does not result in energy savings while EE can reduce load significantly, over many hours of the load shape and for many days of the year, thereby saving energy as well as reducing peak demand)

illustrative example for a large commercial office building **comparing two scenarios**:

- ✓ EE measures for lighting and cooling that reduced load by 20%
- ✓ LM defined as a four hours curtailment with a curtailment load reduction of 15% achieved by reducing lighting and HVAC load

How do DR and EE compare - 4



How do DR and EE compare - 5

- **DR needs to re-sign or re-commit the load reduction** in subsequent years

  … while

  EE reduces load over the life of the energy efficiency measures, typically for many years **without any need to re-sign or re-commit the load reduction in subsequent years**

How do DR and EE compare - 6

- **DR typically results in a reduction of the level of end-use service or amenity**…

  … while …

  EE does not reduce the level of end-use service or amenity, i.e. reduces “energy intensity”

How do DR and EE compare - 7

- **DR resources are not automatically dispatched** by customers **without requiring market or system intervention** by system operators or schedulers …

  … while …

  EE resources are automatically dispatched by customers and always **without requiring market or system intervention** by system operators or schedulers

How do DR and EE compare - 8

- **DR may have some positive environmental impact** to the extent that:
  - baseload units are substituted for peaking ones (and peaking units are less efficient than baseload ones),
  - new additions to electricity generation (and/or transmission and distribution) are cancelled or delayed …

… while …

EE reduces the environmental impacts of electricity generation, transmission and distribution because

- it reduces peak load and
- it saves energy over many hours of the load shape for years

How do DR and EE compare - 9

- **Conclusions:**
  - **all demand-side resources are not created equal**
    - **EE can produce the <u>peak load</u> reduction benefits of DR**

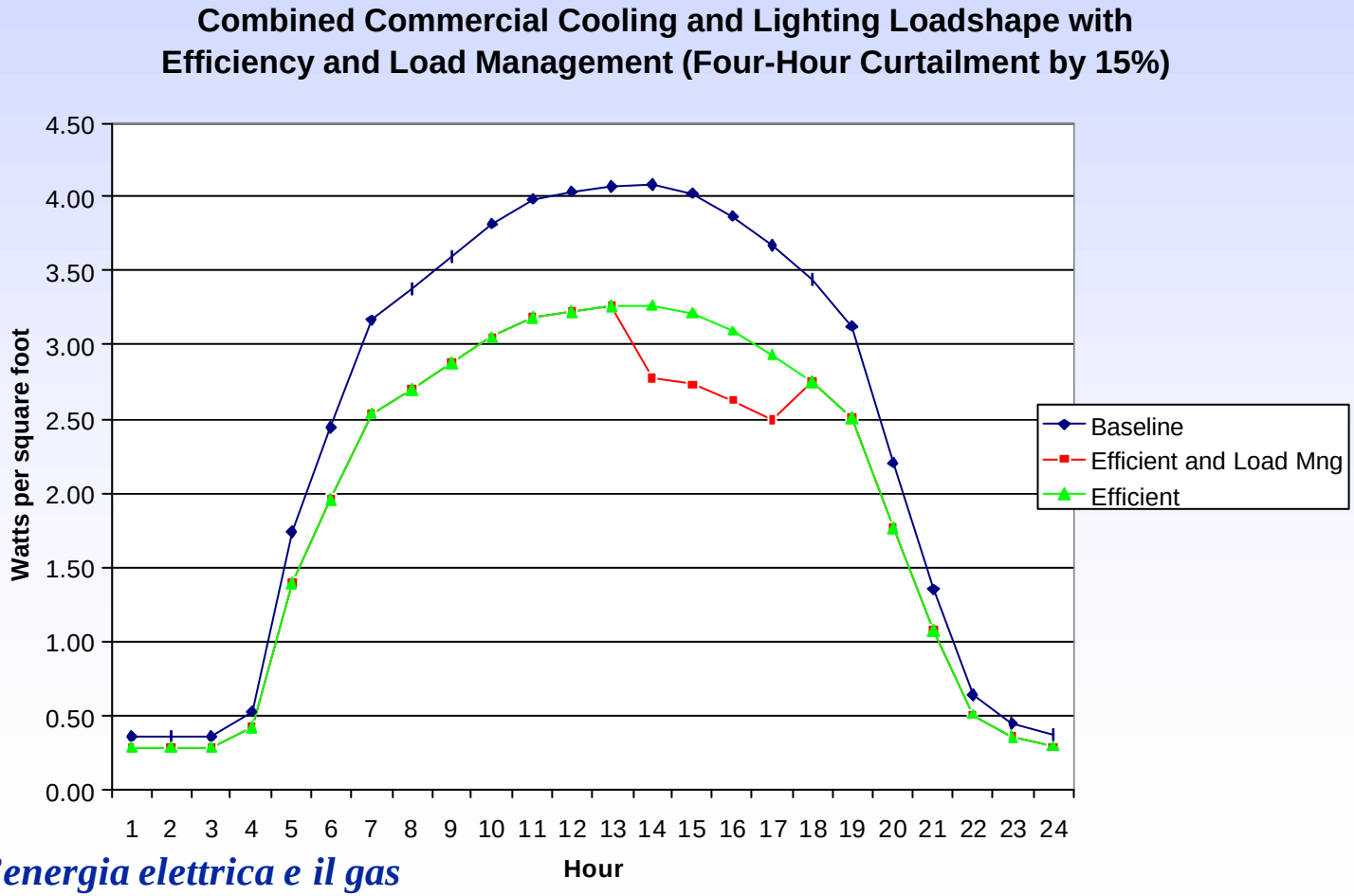
      - in the medium term if the right infrastructure is not already in place, sooner otherwise
      - and produces a number of valuable additional (societal) benefits

    - ✓ **but DR can not guarantee the same benefits of EE in terms of <u>energy savings and emissions reductions</u>**

      - if tight conditions do not develop you do not invoke DR
      - peak load reductions do not necessarily reduce electricity consumed
      - emissions reductions are possible but not guaranteed

How do DR and EE compare - 10

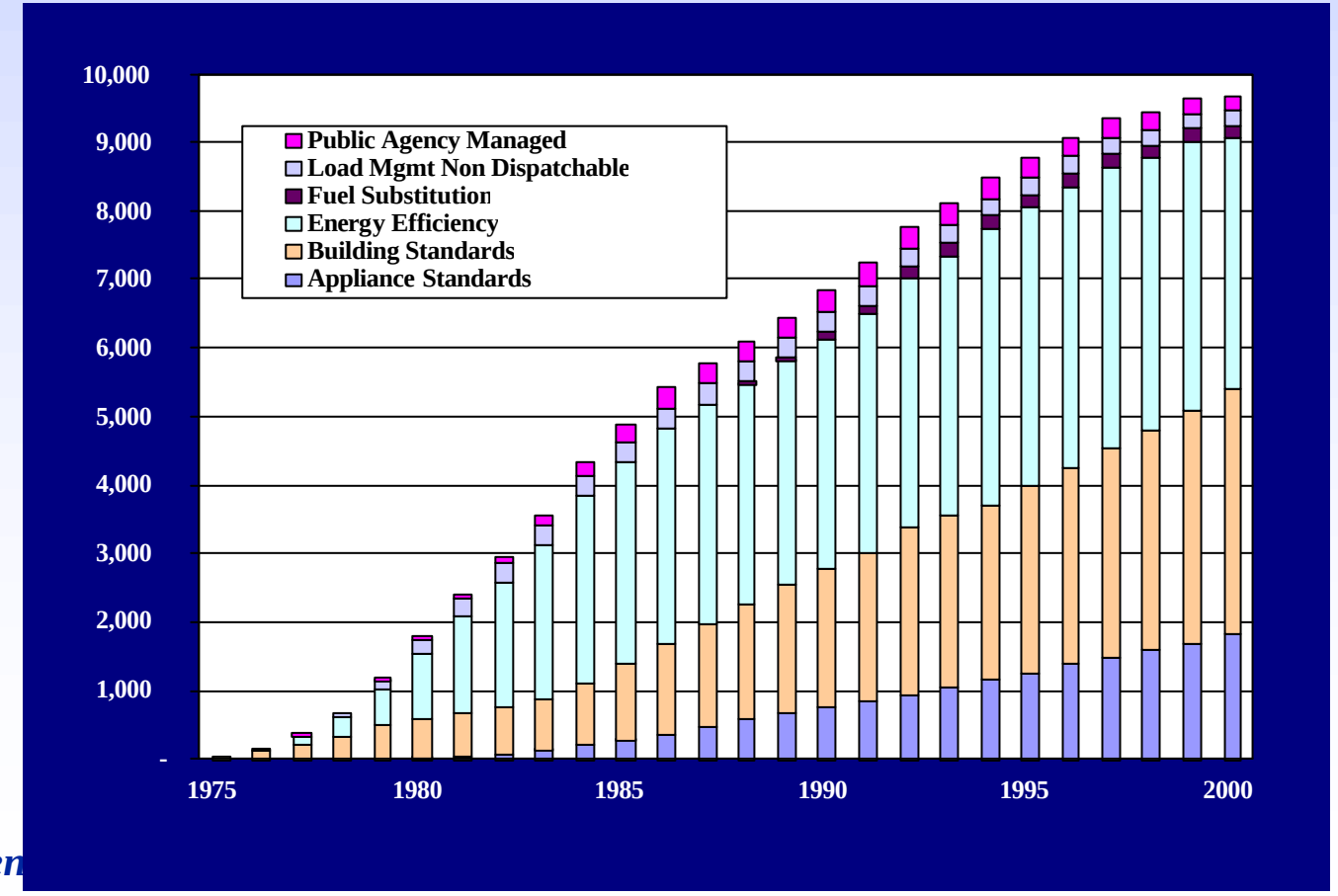
- **both DR and EE are valuable in their own ways** and may be **used as complementary tools to pursue joint objectives**



How do DR and EE compare - 11

(both **DR and EE** are valuable in their own ways **and** may be used as complementary tools **to pursue joint objectives)**

California Peak Load Reductions (MW), 1975 – 2000 from Appliance Standards, Building Standards, and Energy Efficiency Programs



How do DR and EE compare - 12

- **EE may offer a lower cost alternative *when the value of both energy and peak demand savings are considered***

Option	Cost/peak kW–year ($)
Supply-side	
Peaking power plant (capital only)	47
Peaking power plant (including operating costs)	55
Transmission upgrade	22
Local distribution upgrades	20-60
Demand-side	
More efficient chiller	44
More efficient package commercial cooling system	31
More efficient residential air conditioners	62
Residential cooling system tune-up	98
Commissioning of existing commercial buildings	58
Commercial lighting upgrade	25
Commercial lighting design	125
Residential air conditioning load control	53
Residential water heater load control	92
Commercial and industrial interruptible rates	44

Methodological issues - 1

- **Evaluating the energy savings and environmental impacts of EE programs:**

  can not be determined *a priori*

  - **baseline** (technology and level of service/amenity)
  - **free-riders**
  - **spill over** effects
  - impact of different **delivery mechanism**
  - **persistence** of savings over time
  - which **approach** (e.g. deemed savings, direct measurement)
  - **environmental** impact:
    - ✓ generally limited to the **average CO2eq. emissions impact of the number of kWh saved:**

      MJ/kWh X CO2eq./MJ = CO2eq/kWh saved

Methodological issues – 2

- **Evaluating the environmental impacts of DR programs:**
  - **can not be determined *a priori***
  - **relevant impacts are more qualitative than quantitative**
  - **you have to take into account what is happening at the margin rather than on average**

Methodological issues – 3

(Evaluating the environmental impacts of DR programs)

Determining system boundaries

- **Spacial:**
  - **technologies** used
  - **fuel**(s) used
  - average **efficiency**
  - power plants typically used to cover **peak versus baseload** (technology and location)
  - ➔ **reference scenario and post-DR scenario**
- **Temporal:**
  - **short run** (static view): impact in terms of changes in the ways in which the existing capital stock (taken as given) is used
  - **long run** (dynamic view): short term impact + impact on new additions to the existing capital stock (power plants, transmission and distribution lines)
- **Physical:**
  - **environmental indicators** examined (GHGs, air quality, full analysis)
  - phases of the **electricity cycle** taken into account (generation phase only vs LCA)

Which policies - 1

- **May be used as complements** to pursue peak demand reductions as well as additional benefits related to EE …
- **…but the electric industry prefers DR and is mildly adverse to EE because:**
  - DR lowers peak demand during the highest cost time periods without really reducing their total sales or throughput of electricity while EE may reduce peak demand, but it also reduces overall sales and this can adversely affect short term profits
  - the societal benefits produced by EE are external to the utility's short term financial interests

Which policies - 2

- **This means that there is a need for government/ regulatory programs and policies to make EE programs happen: e.g.**
  - EE obligation on distributors/suppliers
  - system benefits funds collected through wires charges
  - building codes and appliance and equipment standards
  - fiscal policies

- **In addition supply-side policies should be developed aiming at:**
  - raising the efficiency of existing power plants
  - increasing the capital stock turn-over (replacement and new addition)