Guaranteeing that the lights always come on – how much is this really worth?

Presentation for

NEW ZEALAND INSTITUTE FOR THE STUDY OF COMPETITION AND REGULATION INC.

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seo economisch onderzoek

Background

- Attention for Supply interruptions
  - Californië 2000/1
  - Northeast USA & Canada, London, Sweden/Denmark, Italy 2003
- Electricity shortages?
  - (Dutch) reserve capacity decreased
  - Dutch network seemed to decrease

- New Zealand:
  - Large black-out in Auckland
  - Long black-out in Western part of South Island
  - Electricity shortages in cold and dry winters
  - HVDC link out of order
  - Taking supply security into account for transmission investment

Major versus minor disruptions

Major disruptions dominate debate, minor often reality

- **Last major disruption in Netherlands: 1997**
  - **once about every 10 years**
- **Bailek (2003) analyzed several large disturbances**
  - **Common denominator: communication and bad luck.**

- **In 2004: 16.436 electricity disruptions caused 24 minutes of supply interruption (NL). 1997 interruption added 15 minutes on average**
- **Statistics work, so general rules are possible**

Key Questions

- **What is the cost of not having electricity?**
- **How to reduce the damage when there is a sudden shortage of electricity (and the market can not help to solve the problem)?**
- **How much to invest and where?**
  - **Grid**
  - **Reserve capacity of generation**
- **What rules give energy companies the right incentives?**
  - **N-1**
  - **Turnover of distribution companies**

Outline of the presentation

- Characterizing supply interruptions
- Consequences of interruptions
  - Firms & Households
  - Interruptions with or without transfers
- Valuation methods
- Results
  - Damage per hour
  - Value of lost load
- Policy implications
  - Optimal distribution in case of scarcity of supply
  - Optimal investment
  - Network management

Characterizing interruptions

- Type of consumer
- Moment
- Length
- Cause of the interruption

- Announced?
- Expected reliability
- Structural or incidental

Consequences of outages

- **Network problems: only social costs:**
  - **Firms:** » **Loss of production**
    - Material damage
    - Restart cost
    - Overwork?
  - **Households:** » **Loss of leisure time**
    - Stress
  - **Distress of public services**
- **Production shortages: social cost & price increases: transfer of wealth: can exceed the social cost**
    - California: damage $0.5 billion, transfers $40 billion
    - Politically very relevant
    - Maximum prices can be used as an imperfect solution, they reduce supply and may cause outages.

Valuing the consequences

Market is missing: different economic tools:

- **Interviews**
  - **estimation of damage, WTP, WTA, conjoinct analysis**
- **Expenditures on back-up facilities**
- **Case studies**
- **Production function approach**

Quantification method

- **Direct effects calculated:**
  - **Production losses (value added) in firms**
  - **Loss of leisure (households; hourly wages)**
- **Simplifying assumptions:**
  - **All production and leisure is lost**
    - Direct loss is most likely smaller
    - But: there are also other cost (e.g stress)

    ➔ Reasonable first order approach
  - **Damage proportional to time**
    - Approximation of the relationship between length and damage
    - Seems reasonable within parts of the day

Quantification: more details

- **Damage of firms**

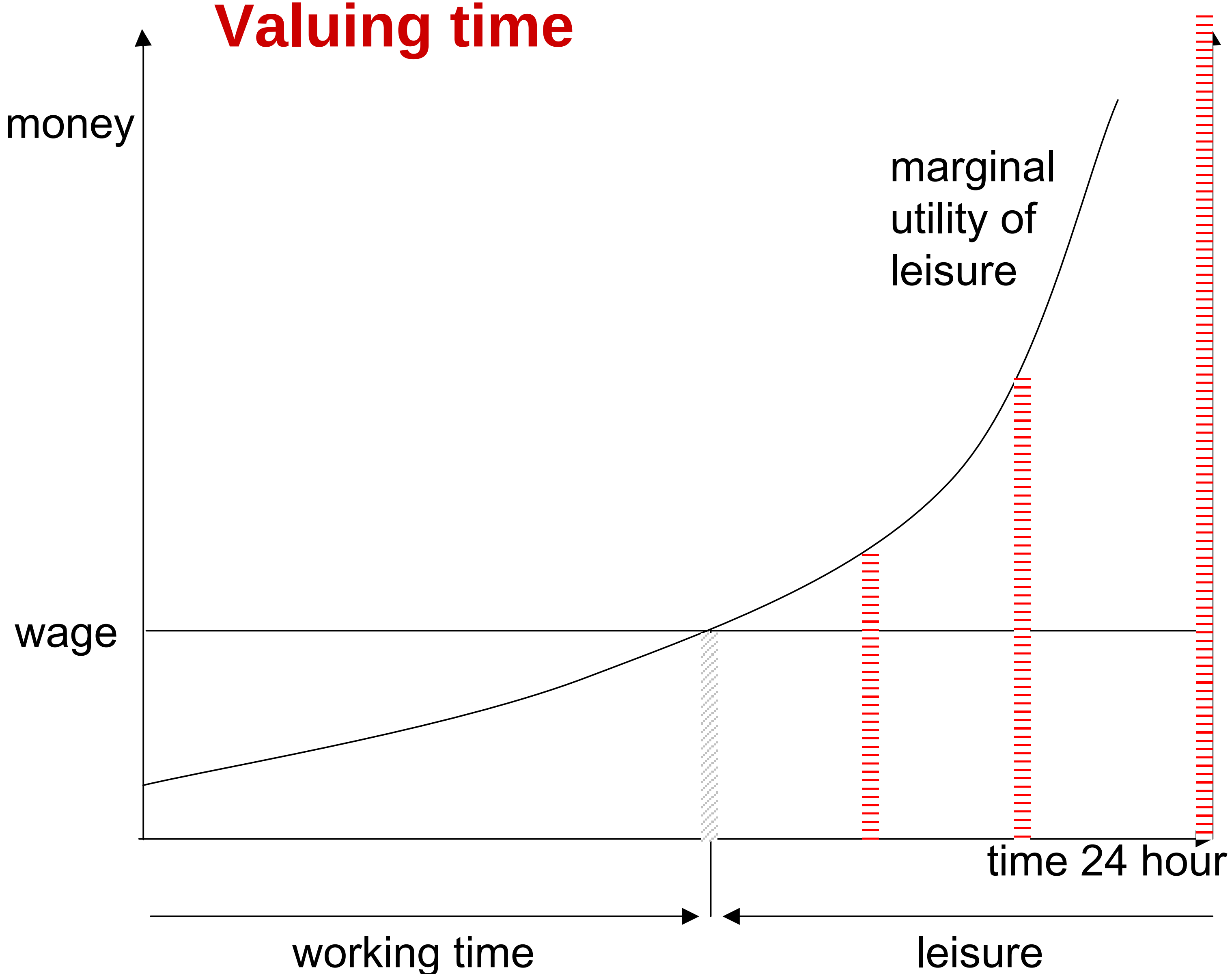
  = value added which would have been produced during the outage

- **Damage of households**

  = value of lost leisure
  = number of people that would enjoy leisure during the outage but can't because of the outage times the average hourly wage net of taxes (for non-working people half the average hourly wage was taken)

- **We distinguished nine different periods and several industrial sectors**

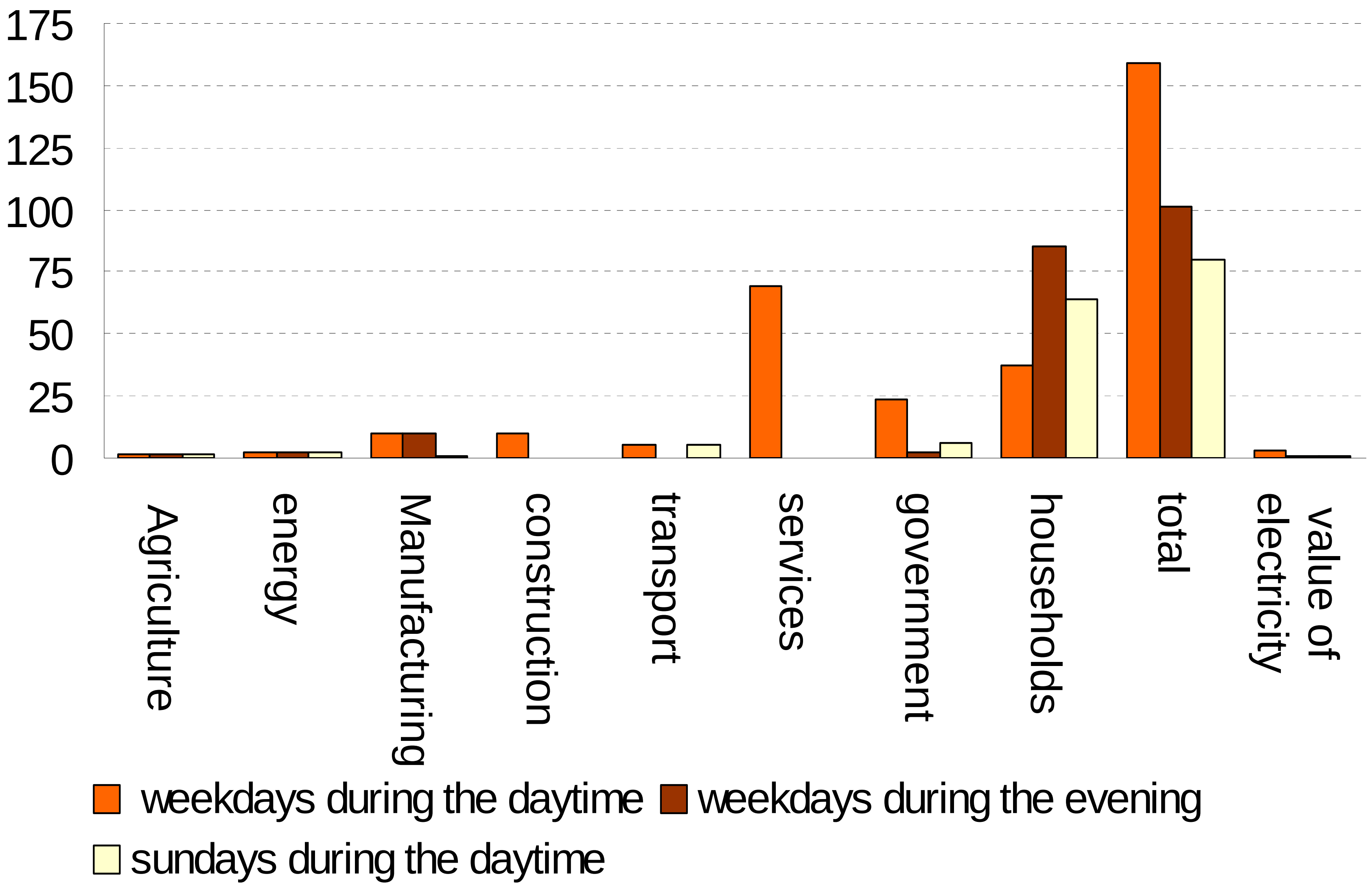
Valuing time



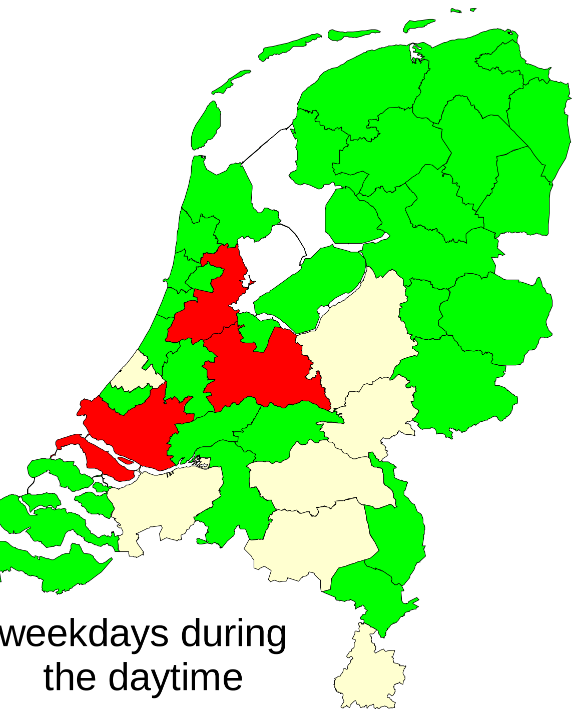
Key figures per sector (2001)

	electricity use (1000 gWh)	'value' (bln euros)	Cost of a one hour outage weekdays dur-ing the daytime	value of lost load (€/kWh)
Agriculture	3	11	1.3	3.9
energy sector	-72	23	2.6	-0.3
manufacturing	34	63	10.2	1.9
construction	1	25	9.5	33.1
transport	2	20	5.4	12.4
services	25	198	69.3	7.9
government	2	80	23.7	33.5
firms	67	397	122.0	6.0
households	22	362	37.4	16.4
total	89	759	159.4	8.6

Damage per hour per sector

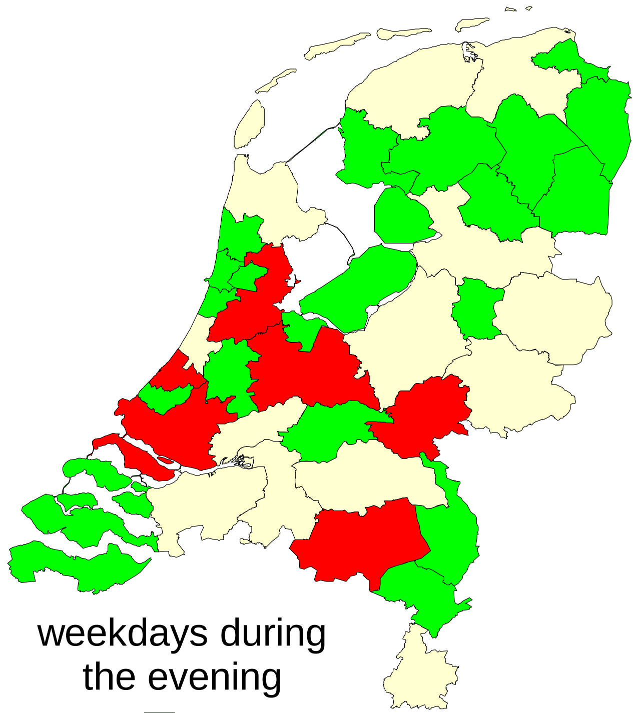


Welfare per region (mln. € per hour, 2001)



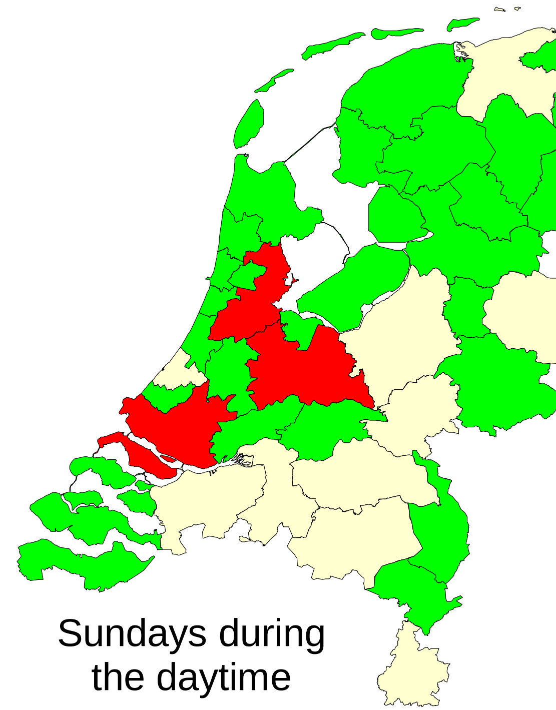
weekdays during the daytime

- 0 to 5
- 5 to 10
- 10 to 20



weekdays during the evening

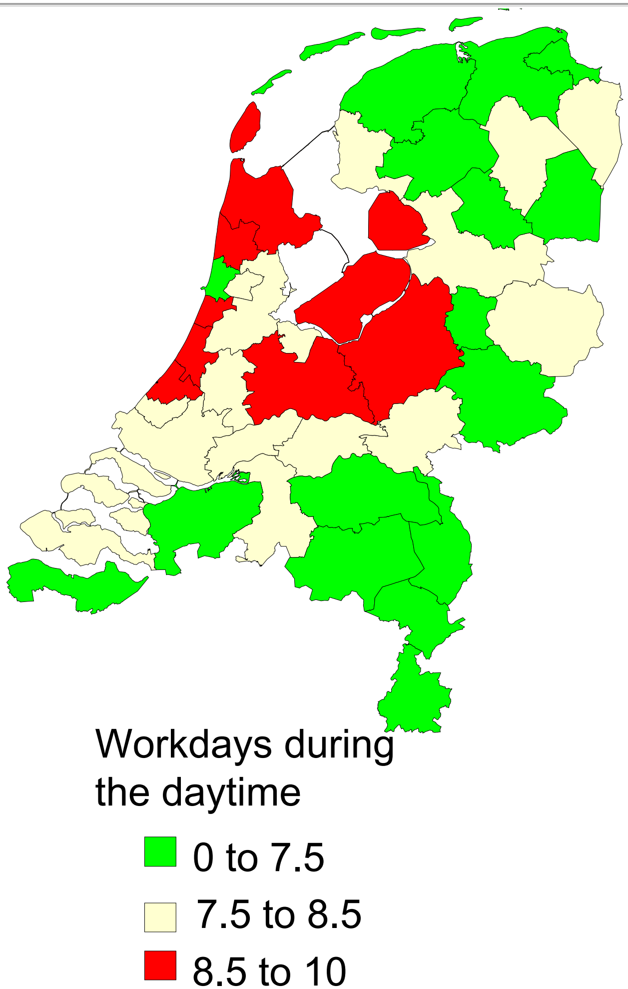
- 0 to 2
- 2 to 4
- 4 to 9

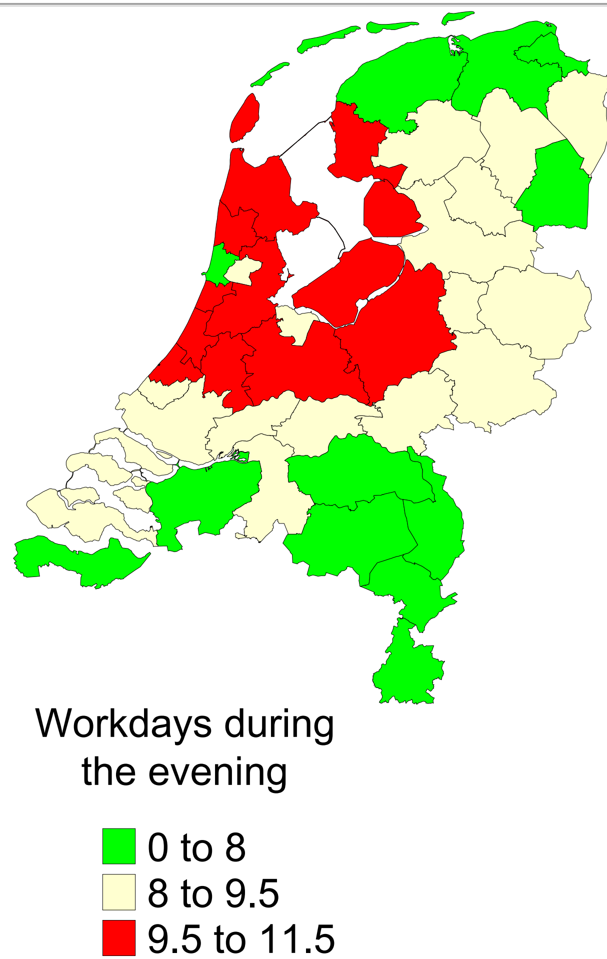


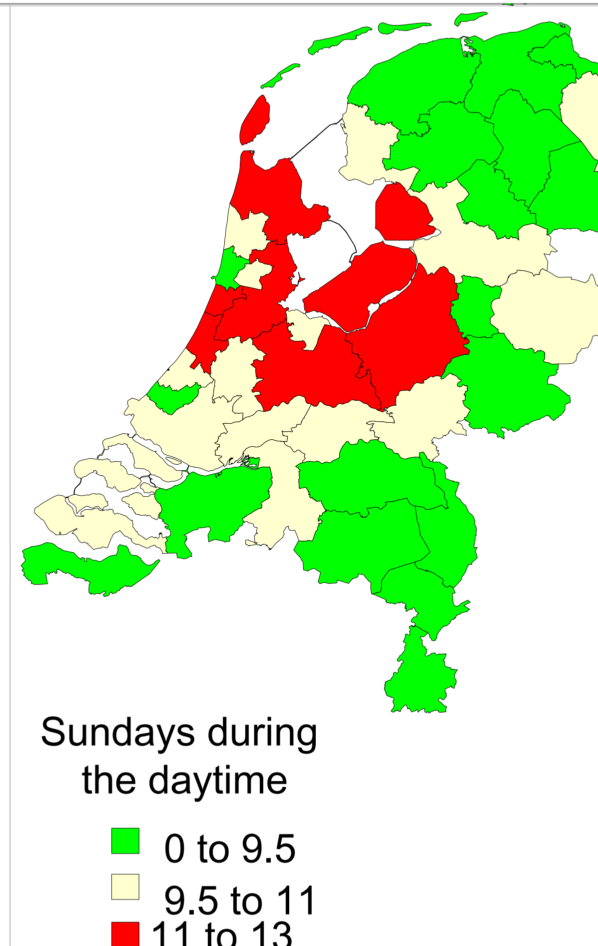
Sundays during the daytime

- 0 to 2
- 2 to 4
- 4 to 7

VOLL (€/kWh, 2001)







Value of lost load and damage, all moments (2002)

	Voll (€/kWh)	Damage of a one hour interruption (€ mln)
Workdays daytime	7.7	155.9
Workdays evening	8.4	99.1
Workdays night	2.5	17.3
Saturdays daytime	8.4	146.6
Saturdays evening	11.5	93.1
Saturdays night	3.4	12.8
Sundays daytime	9.4	81.9
Sundays evening	11.5	93.1
Sundays night	3.4	12.8
average	*7.3*	*89.7*

Use (in policy)

1. **Shortage of supply**
2. **Optimal investment**
3. **Network regulation**

Policy: Criteria and norms

- **Possible criteria:**
  - **Economic optimality**
    - Social cost and benefits
  - **“justice”**
    - Equal probability (for interruptions)
  - **Or a combination**
    - Minimum level of reliability
    - Additional reliability on economic grounds
- **Focus: economic optimality**

Reactions to a shortage of supply (i)

Shortage leads to high prices:

- **Producers: generate more electricity**
- **Users: consume less (interruptible contracts, direct demand response to high prices, ...)**
- **Government:**
  - **Loosen regulation to increase production**
  - **Stimulate electricity saving**
- **If these reactions are not sufficient, TSO has to interrupt users**
  - **What role for the consequences of outages?**
- **For the Netherlands, we calculated that efficient rationing can reduce social costs by 21 to 93 percent compared to random rationing (using data for each municipality).**

Reactions to a shortage of supply (ii) Policy versus efficiency

- Reality (the Netherlands):

1. Electricity system
2. Public order and safety, health care
3. Critical processes in manufacturing, public utilities
4. Remaining industrial sectors, public buildings, companies and firms.

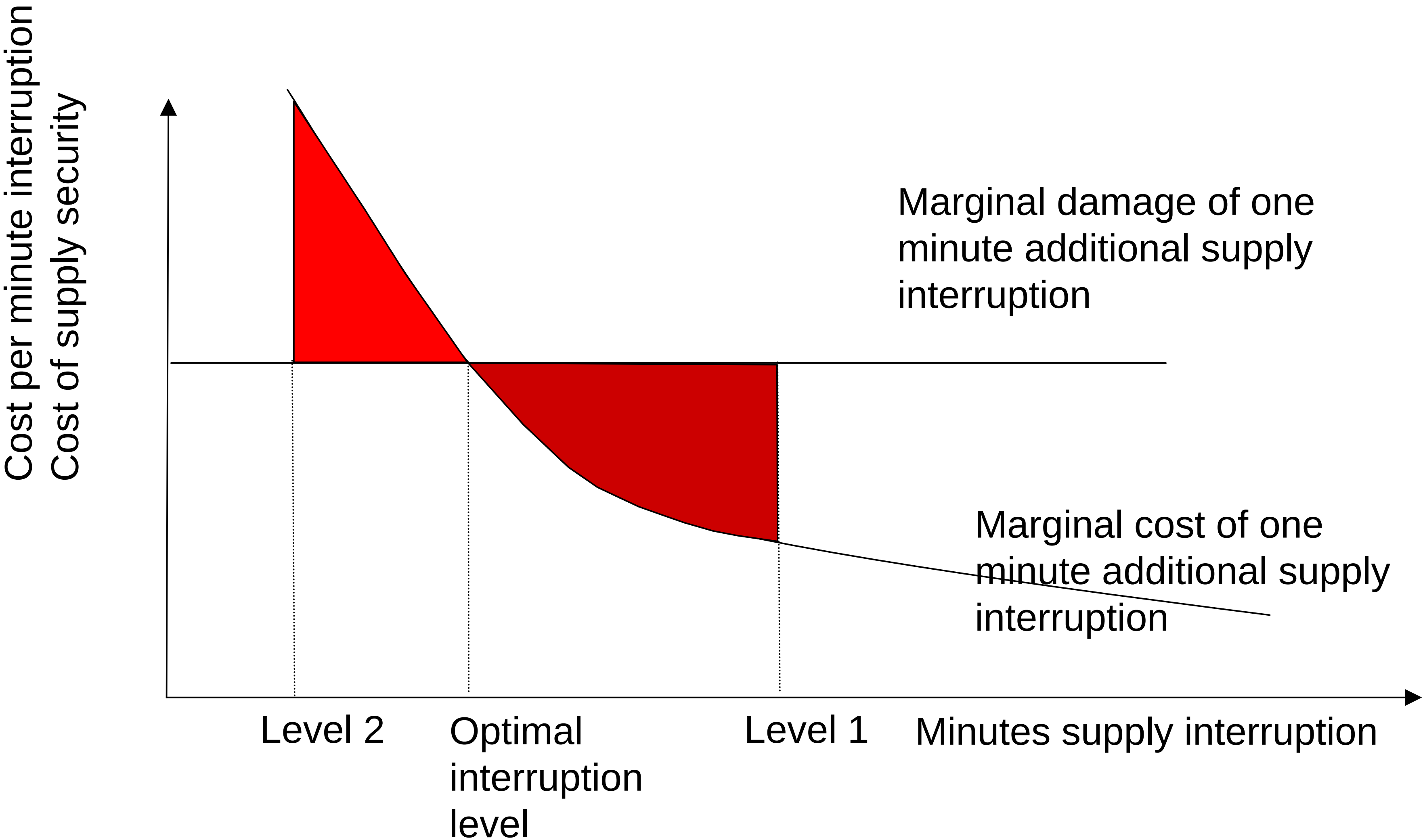
- Households not mentioned
- Differences in economic versus random rationing

- Economic efficiency: sectors/regions with a low voll first:

1. Electricity system
2. Government/ construction
3. Households
4. Services
5. Manufacturing

Top of the list: most priority, sector least likely to be interrupted

Socially optimal investments



Socially optimal investments (ii)

- **Reserve capacity of generation.**
  - **Optimal quantity?**

Network regulation (i)

(Distribution) network operators can best take investment and operational decisions, but their incentives must be right.

NL:

Turnover(t)=turnover(t-1)+CPI-X-Quality

- **Quality: minutes of power interruptions times ‘price’**
- **In the Netherlands this ‘Price’ based on conjoint analysis**

Conjoint analysis (i)

Baarsma et al: ‘competing colleagues’

Problem of contingent valuation studies: Questions are difficult, for example:

- **Imagine an outage of 5 minutes on Thursday evening during the winter, without an advance warning. How much would you be willing to pay to prevent such an outage?**

  82% of the households and 83% of SME said they did not want to pay anything.

- **Therefore they used vignettes**
  - **Each vignette different from the others in terms of duration, frequency, time of the year, …**
  - **Households and firms were asked to value a number of different vignettes**
  - **Followed by some econometrics, gives….**

Conjoint analysis (ii)

Duration of the outage:	Households	
	Total	Average /hour
One outage (per year) of half an hour	1.70	3.40
One outage (per year) of an hour	5.00	5.00
One outage (per year) of four hours	11.60	3.90
One outage (per year) of eight hours	14.90	1.90
One outage (per year) of a day	20.10	0.80
Number of outages:	Households	
	Total	Average / outage
No outage (F_0)	-10.30	
One outage per year (of two hours)	8.50	8.50
Two outages per year (of two hours)	11.20	5.60
Four outages per year (of two hours)	13.90	3.50
Six outages per year (of two hours)	15.50	2.60
Twelve outages per year (of two hours)	18.30	1.50

Network regulation (ii)

- **N-1**
- **20 percent of Dutch households at the end of a line instead of using a ring structure (two lines).**
- **Solving that would cost €900 million in investment and 90 million annually.**
- **Benefits €3-4 million a year**

Summary I

- **Costs vary strongly between regions and times**
- **Households are important**
  - **Welfare is more than financial damage**
  - **Voll households exceeds voll manufacturing**

➔ **Distribution of power and investments should take both into account**

- **Damage is larger than the price of electricity**

Summary II

- Transfers are not a cost, but matter anyway
  - Maximum prices reduce redistribution, but cause social cost
  - Redistribution is a political issue
  - Policy w.r.t. scarce electricity could be more efficient
- Cost of power outages can be used for investments appraisal
- Cost of electricity outages should get a place in the regulation to give distribution companies the right incentives
  - Not too much interruptions, but also not too much reliability
- Users could accommodate to interruptions:
  - Possibly cheaper than investments in networks and production

Thank you for you attention

Questions?

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