Milano, November, 26th 2013

ANALYSIS AND EVOLUTION OF THE LOAD CURVES OF RESIDENTIAL CUSTOMERS DURING THE YEARS

Simone Maggiore, Walter Grattieri, Massimo Gallanti - RSE

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Summary

1. Introduction

2. Analysis of the load curves

3. Comparison with the past load curves

4. Analysis of consumers' habits

5. Conclusions

Summary

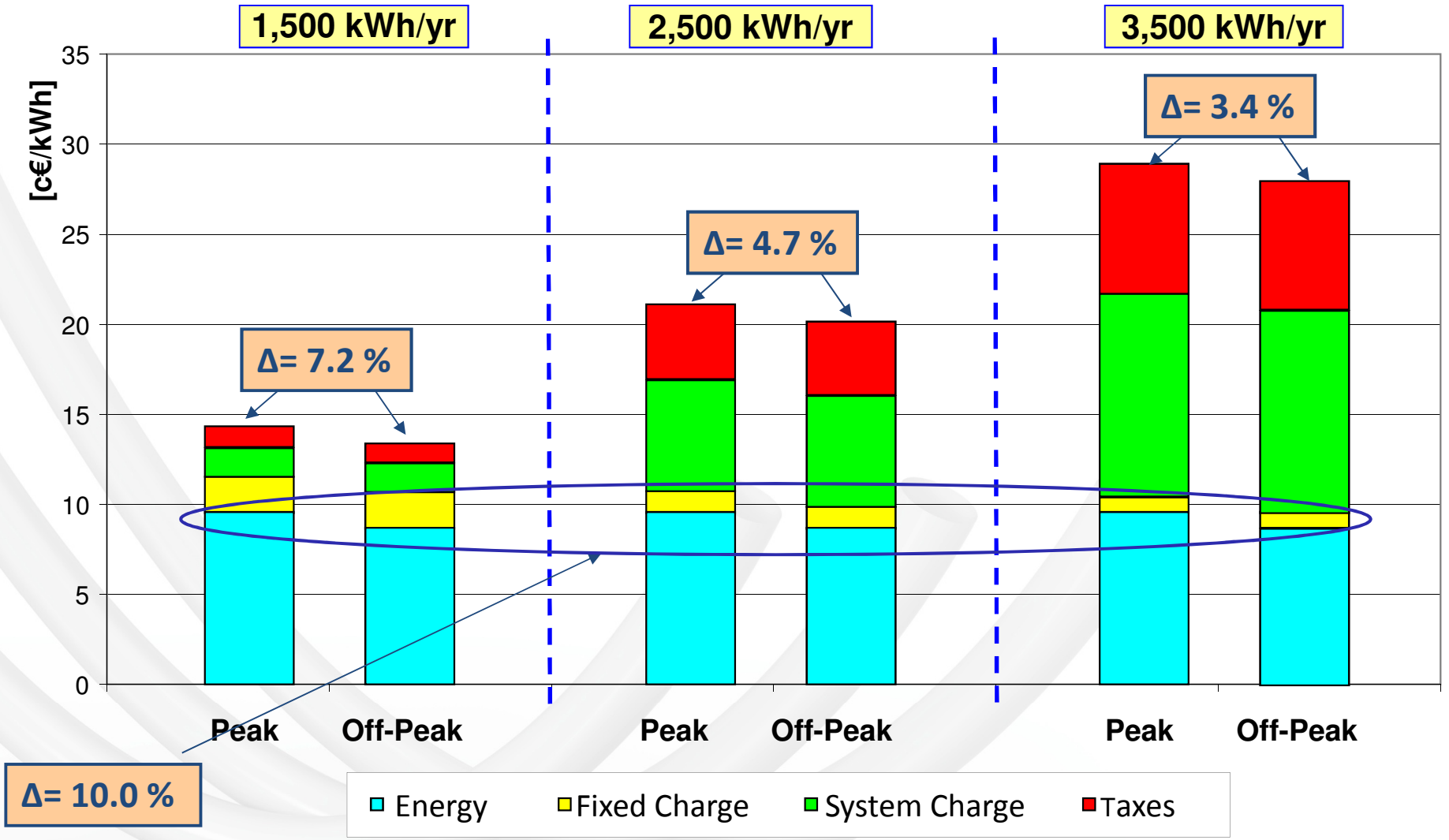
Introduction

Liberalisation of the electric system completed in 2007:

- Production and Sale of electricity are “free”;
- Transmission and Distribution services are regulated;
- Customers can either choose their retailer on the energy market, or be supplied by the local distribution company at a regulated rate *(“Default Service”*)

July, 1st 2010:	Time of Use rates start becoming mandatory for all ***“Default Service”*** residential customers (≈ 25 M customers involved)
ToU Rates:	***Peak hours*** (8.00-19.00 working days)
	Off-peak hours (remaining hours)
Motivation:	make the tariff more cost reflective and progressive expose consumers to time variable costs of electricity supply
Transition period:	up to December, 31st 2011 limited variation between peak and off-peak price
Regular period:	from January, 1st 2012 larger variation between peak and off-peak price

Tou rate (transition period)



Summary

Research project

Scope

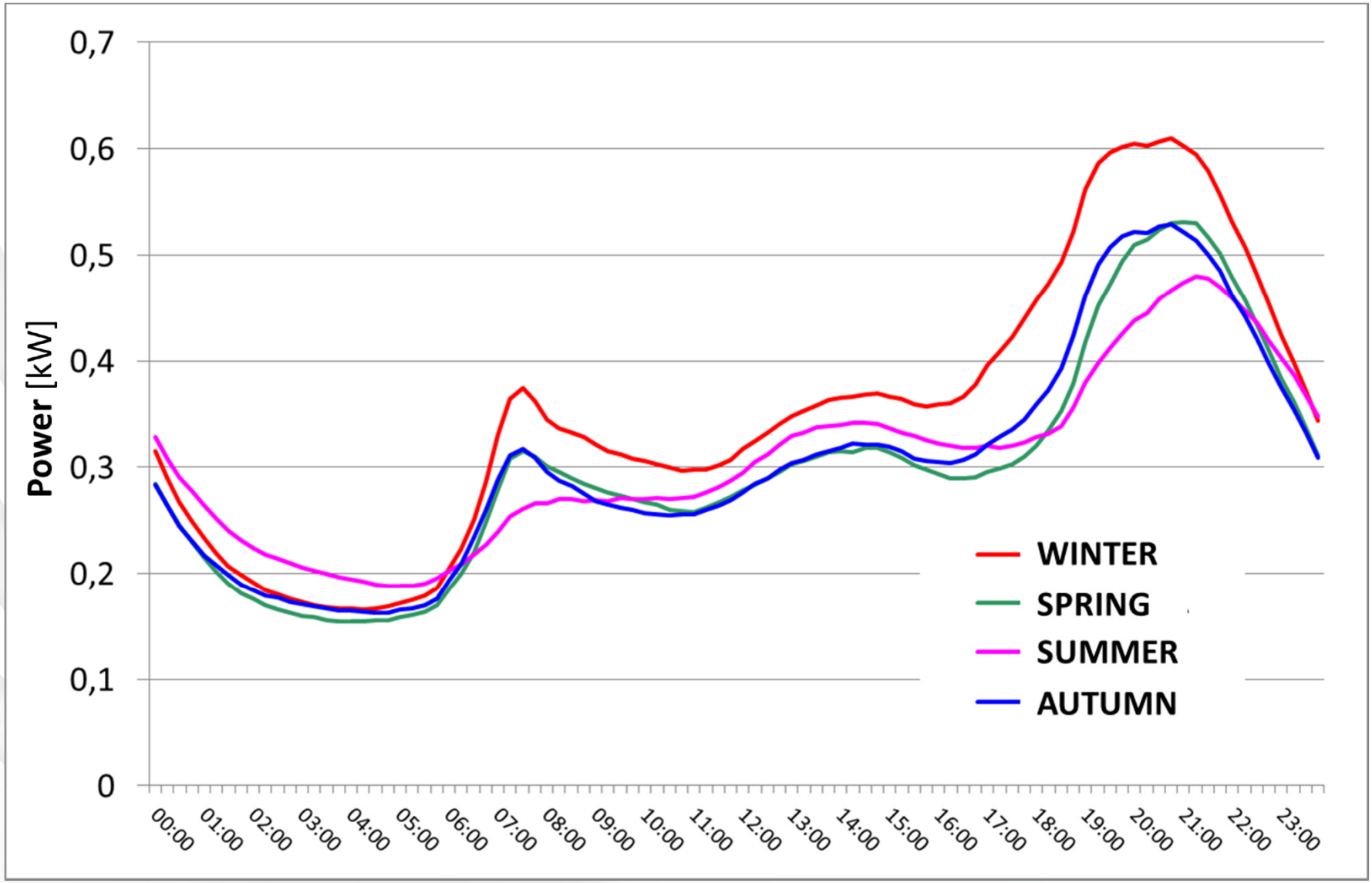
- Derive the average load curves during typical days (*working days, saturdays and holidays*) and different seasons;
- Monitor the load profile/curve and the consumption allocation after the switch from transitional to final ToU tariff.

Main activities

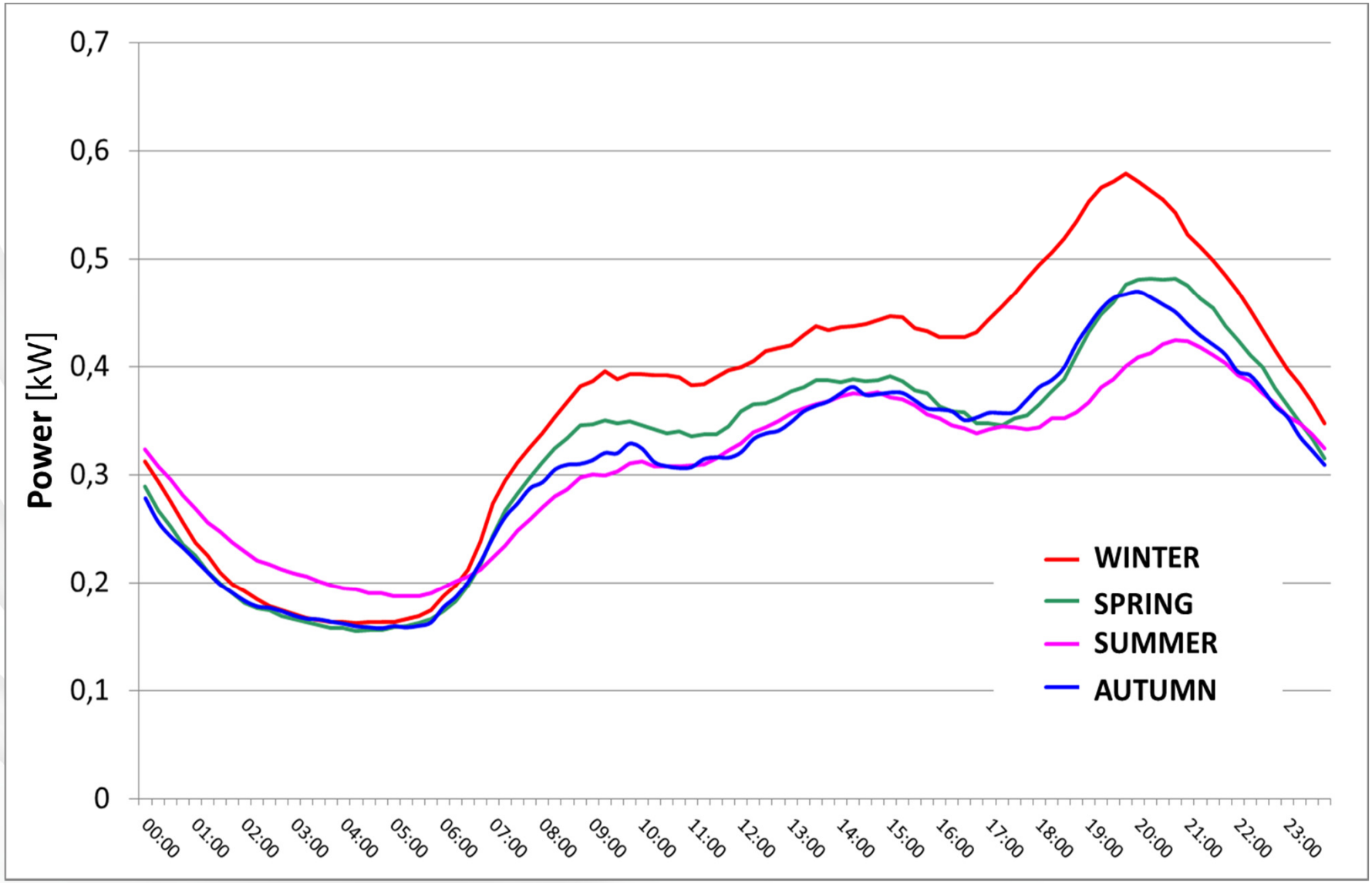
Analysis of the daily consumption with a detail of 15 minutes for sample of about 1,000 families:

- Sample is statistically representative of the Italian population;
- Time series starts in January 2011;
- Time series ends in December 2012.

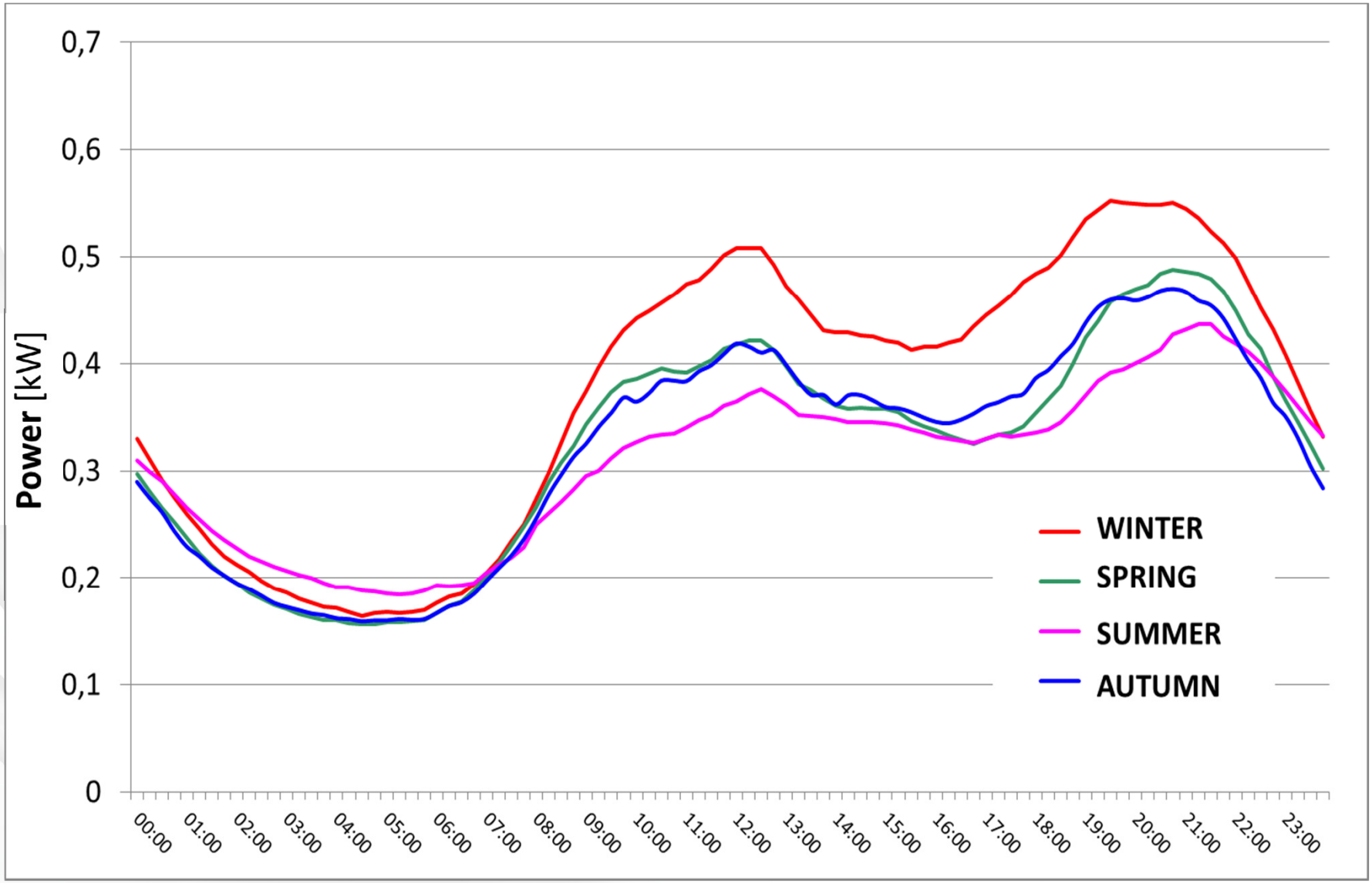
Analysis of the average load curve (working days)



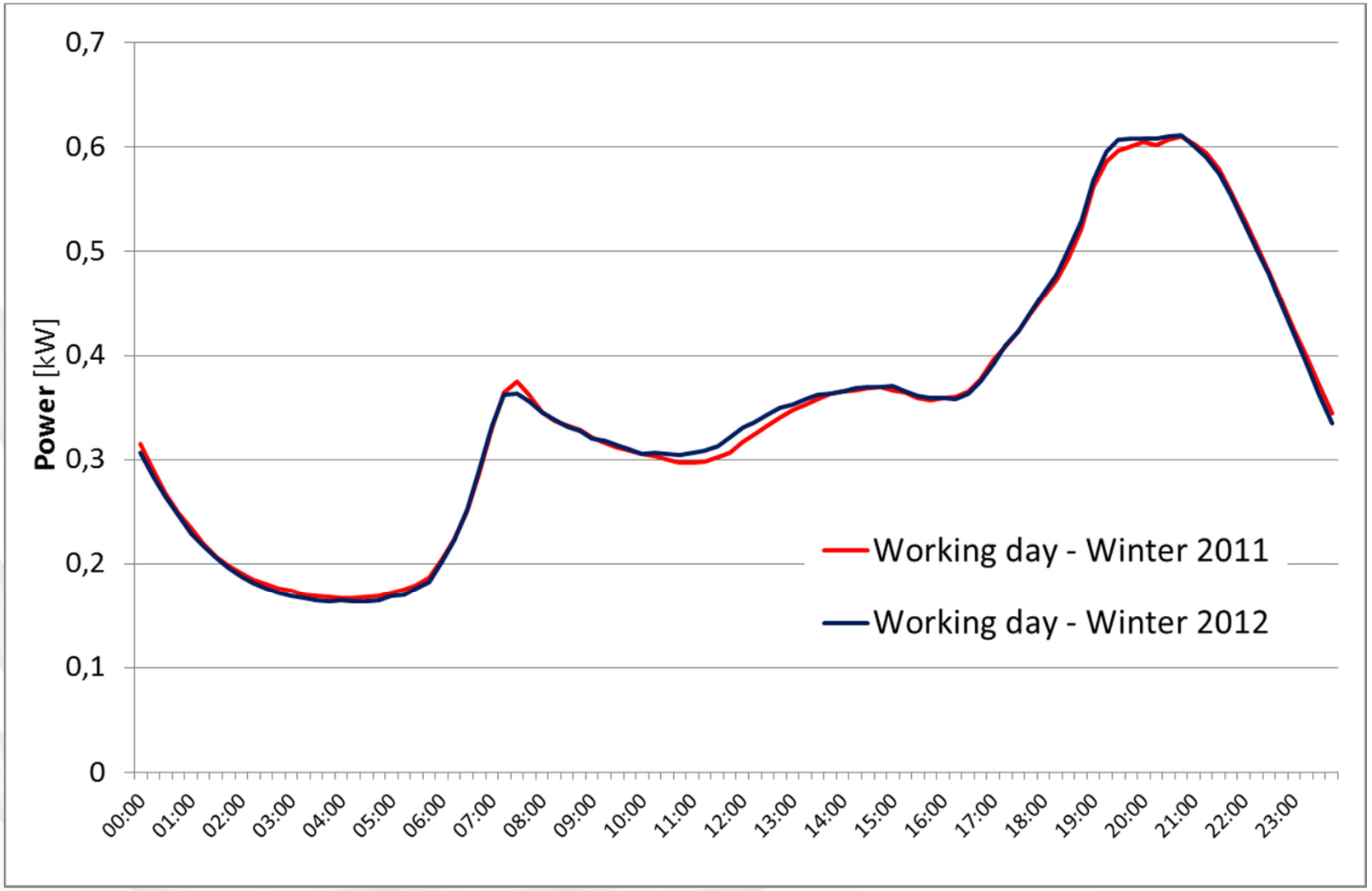
Analysis of the average load curve (saturdays)



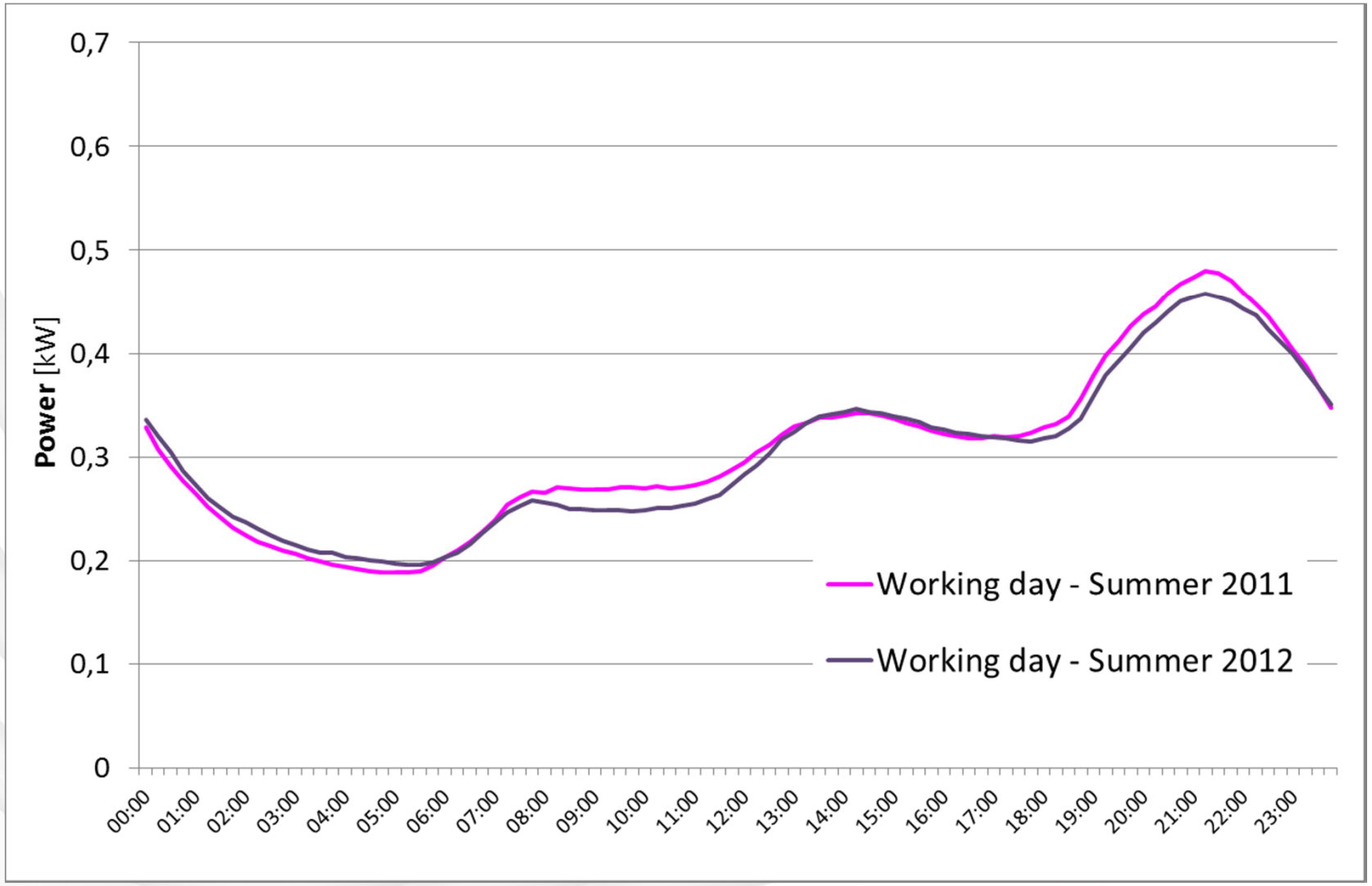
Analysis of the average load curve (sundays and holidays)



Comparison 2011 ***vs.*** **2012** (working days - Winter)



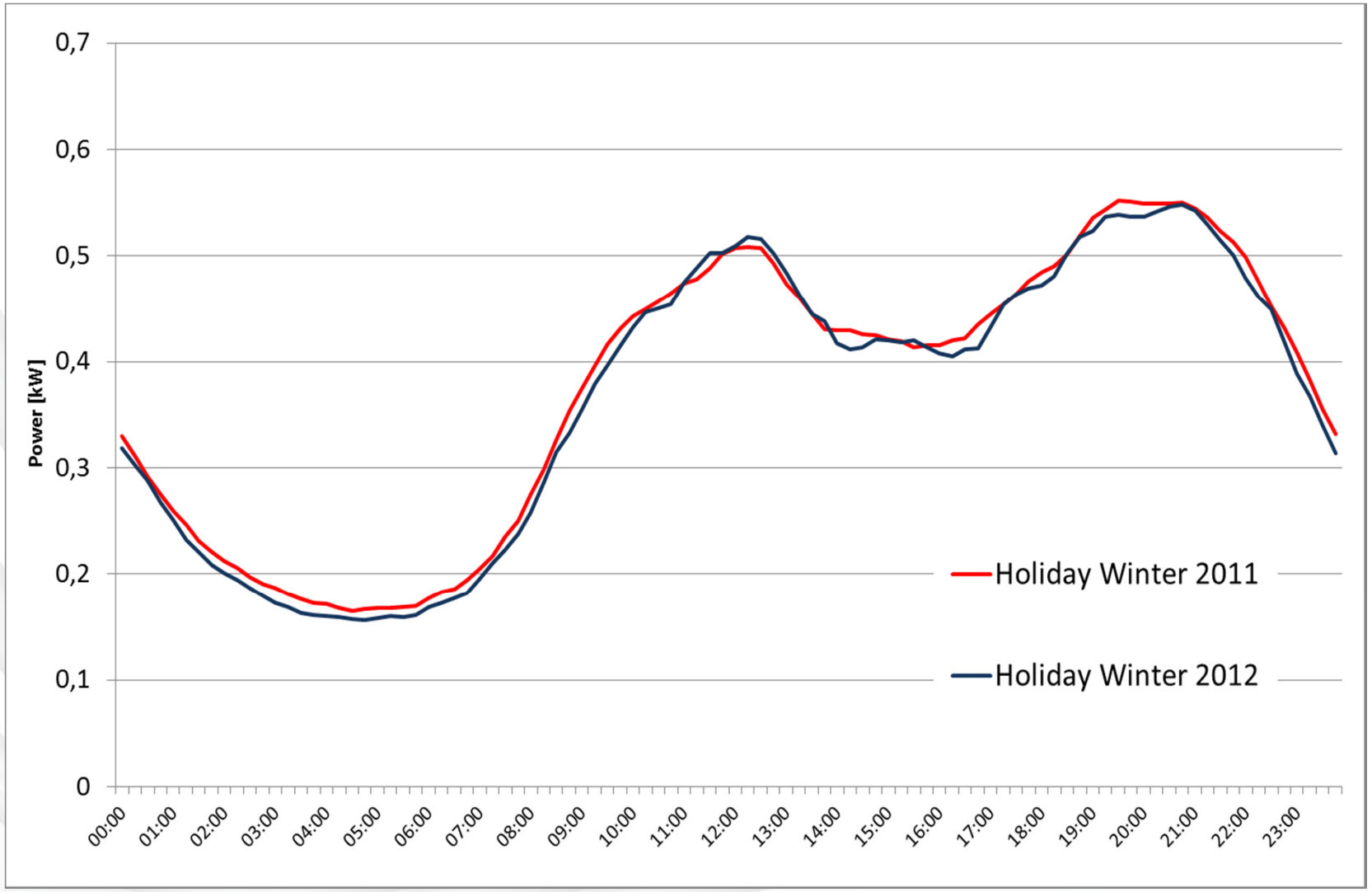
Comparison 2011 ***vs.*** **2012** (working days - Summer)



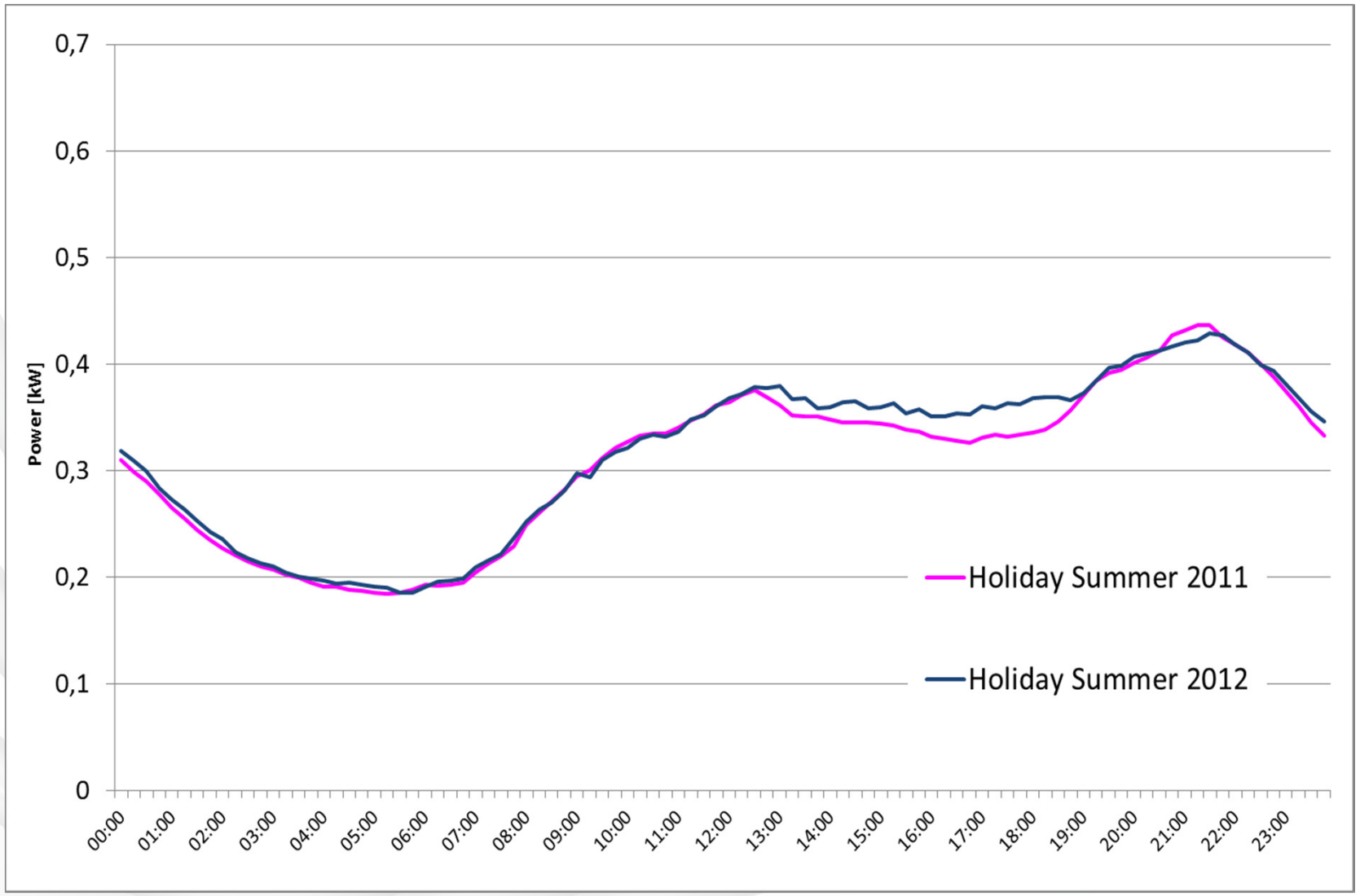
Analysis of consumption allocation 2011 *vs.* 2012
(working days)

Winter 2012 – Winter 2011	Summer 2012 – Summer 2011
Δpeak hours	**Δpeak hours**
0,39%	-0,56%
Δoff-peak hours	**Δoff-peak hours**
-0,39%	0,56%

Comparison 2011 *vs.* 2012 (sundays and holidays - Winter)



Comparison 2011 *vs.* 2012 (sundays and holidays - Summer)



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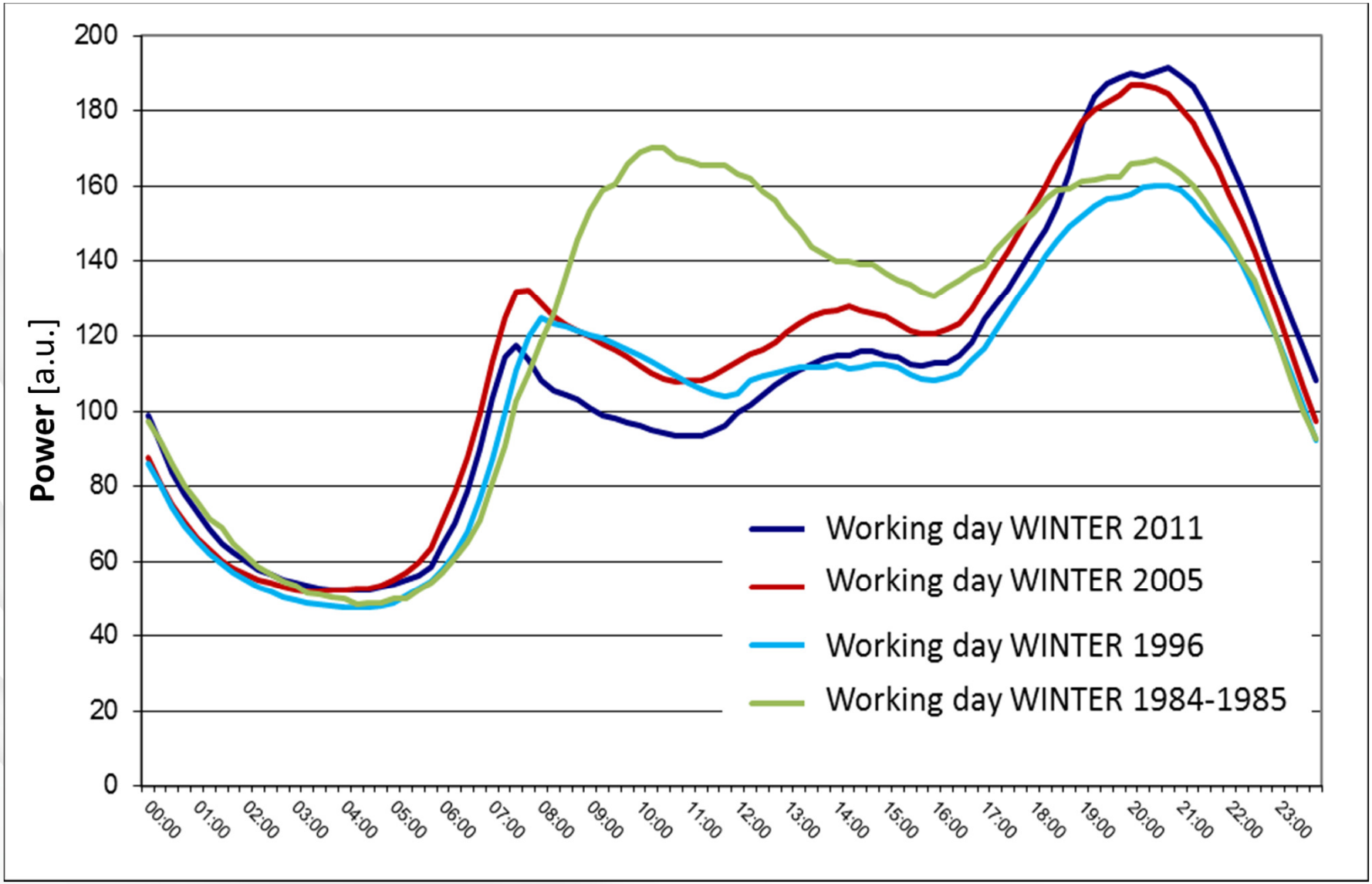
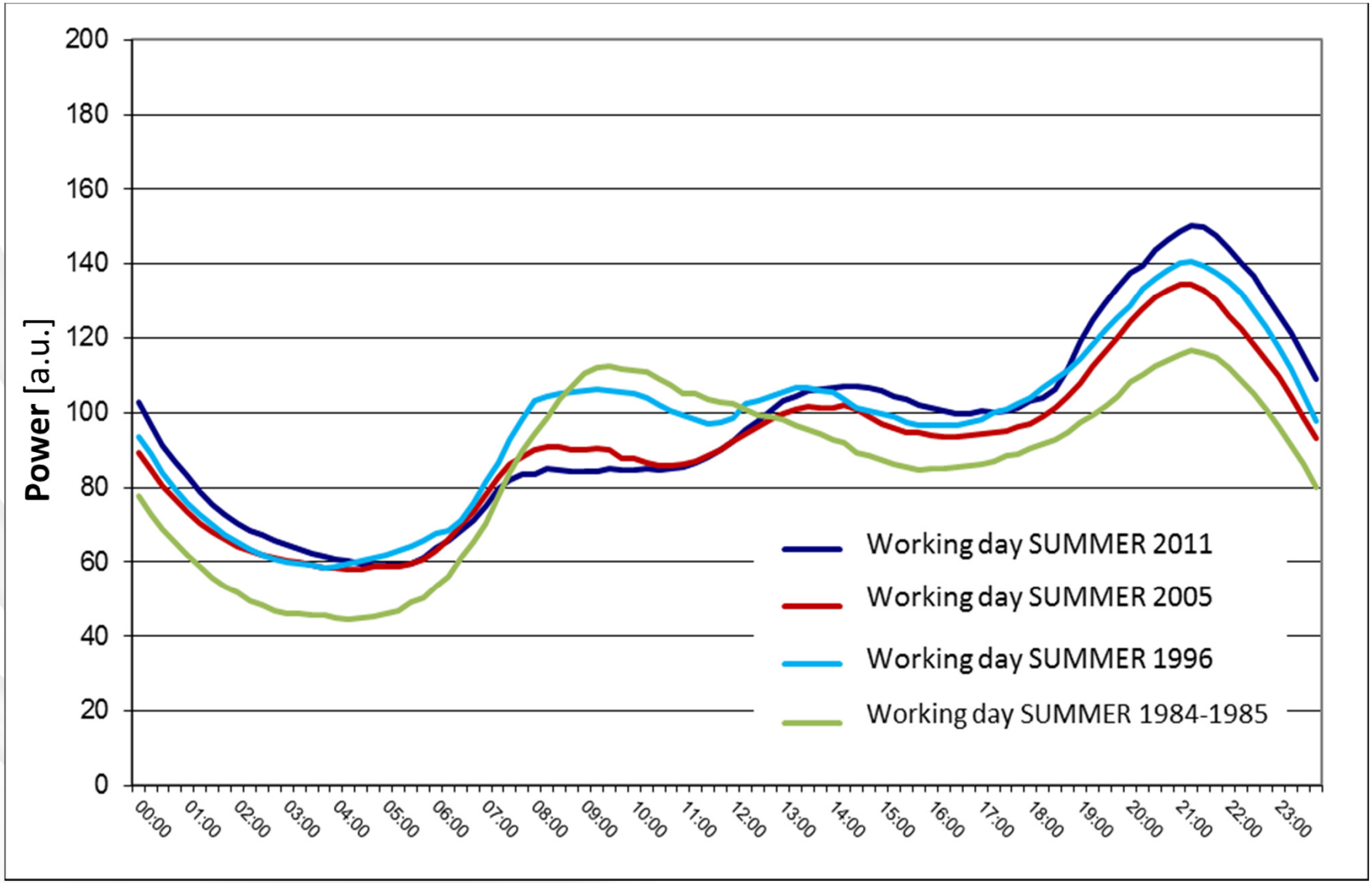
Comparison with the past load curves (working days - Winter)



Analysis of consumption allocation (working days - Winter)

Year	Peak hours	Off-peak hours
1984-85	56.66%	43.34%
1996	51.27%	48.73%
2005	50.18%	49.82%
2011	46.95%	53.05%

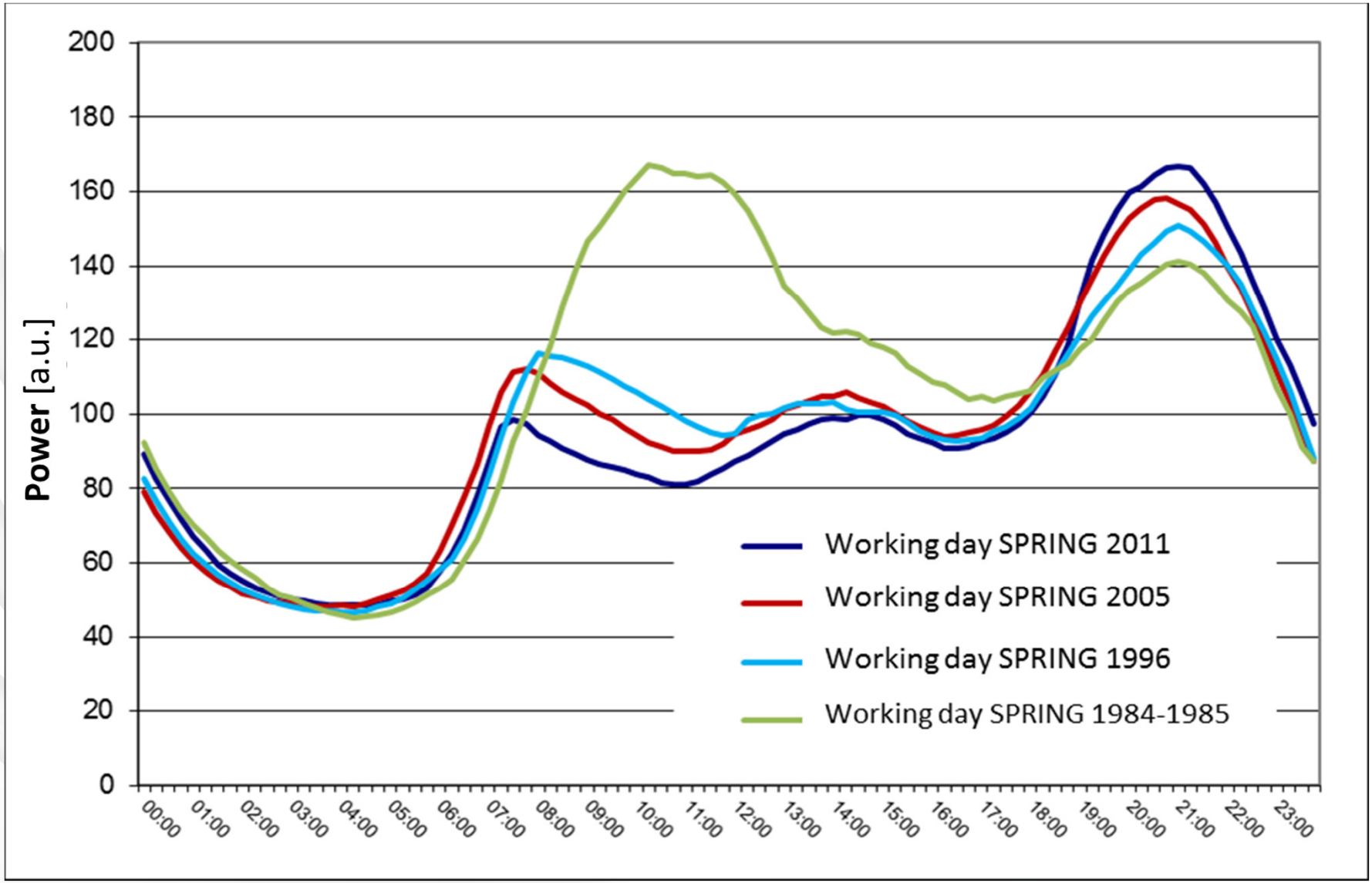
Comparison with the past load curves (working days - Summer)



Analysis of consumption allocation (working days - Summer)

Year	Peak hours	Off-peak hours
1984-85	52.10%	47.90%
1996	50.83%	49.17%
2005	48.67%	51.33%
2011	46.04%	53.96%

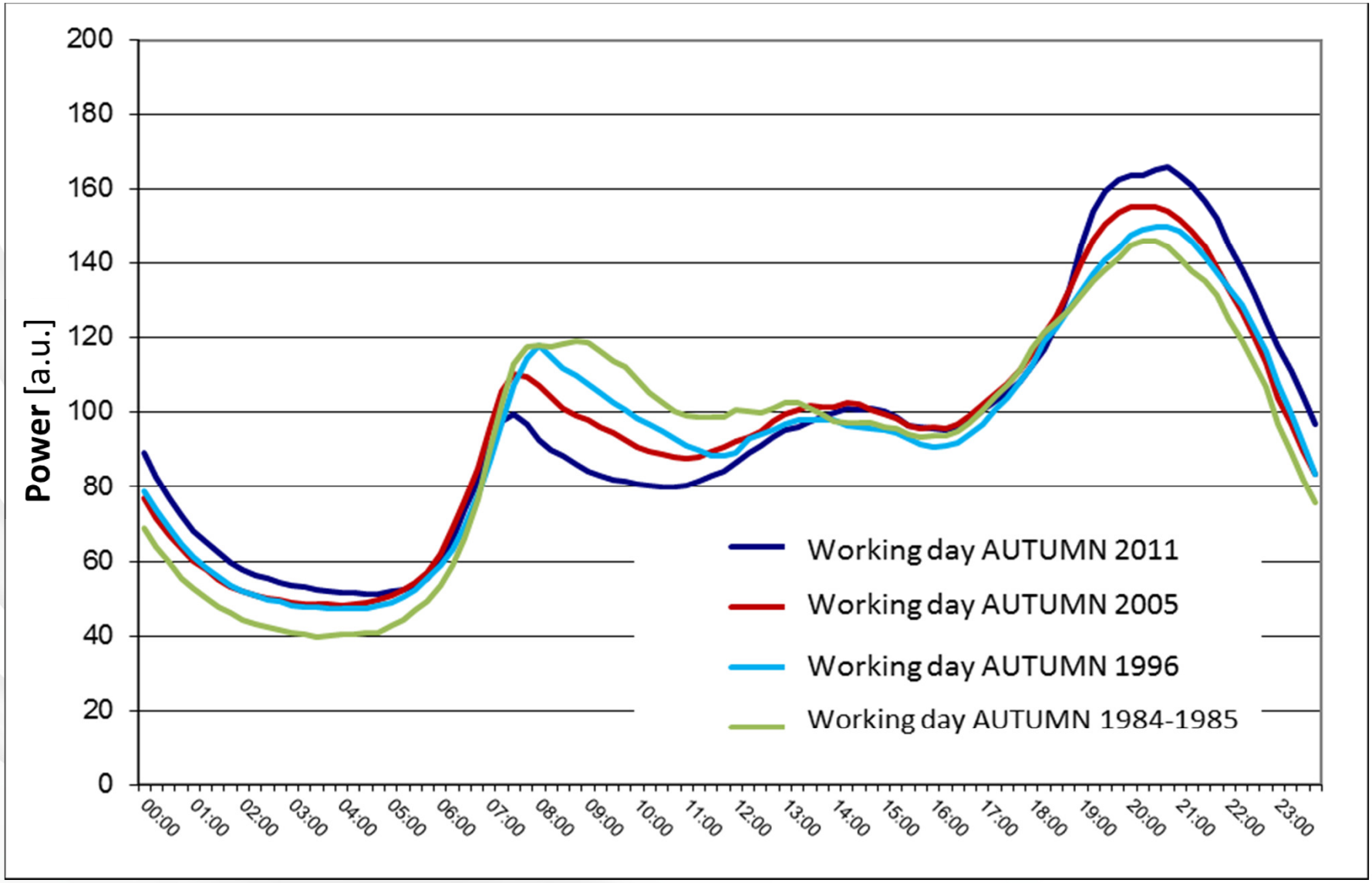
Comparison with the past load curves (working days - Spring)



Analysis of consumption allocation (working days - Spring)

Year	Peak hours	Off-peak hours
1984-85	56.49%	43.51%
1996	50.07%	49.93%
2005	49.50%	50.50%
2011	45.44%	54.56%

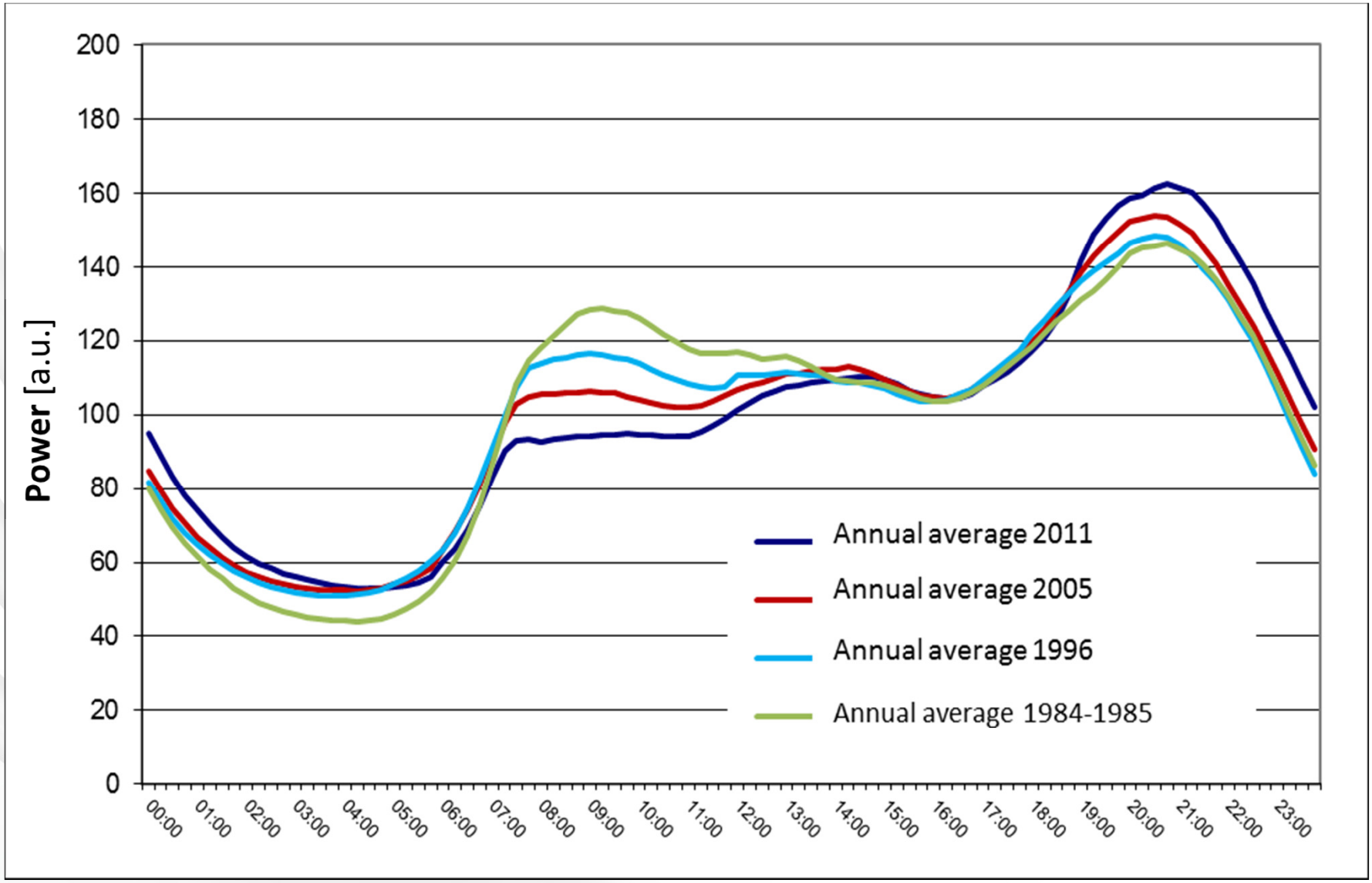
Comparison with the past load curves (working days - Autumn)



Analysis of consumption allocation (working days - Autumn)

Year	Peak hours	Off-peak hours
1984-85	51.88%	48.12%
1996	48.93%	51.07%
2005	48.40%	51.60%
2011	45.58%	54.42%

Comparison with the past load curves
(working days – annual average)



Summary

"Energy Monitor" Statistical enquiry

Scope

- Monitor the ownership of the electric appliances among the families;
- Monitor the habits of use of the appliances (*frequency*, *duration*,…) on the different days of the week and at different times of the day during the year;
- Evaluate families' attitude towards energy efficiency;
- Analyze the impact of the introduction of the ToU tariff on families' behaviour;

Main activities

Statistical enquiry on a sample of about 1,000 families:

- the sample is the same presented before;
- start on October 2010 and end on December 2012.

Enquiry on appliances ownership (1/2)

Appliance	Diffusion 1985	Diffusion 1996	Diffusion 2012
Refrigerator	**95,8%**	**97,2%**	**100,0%**
Washing machine	77,3%	87,7%	99,0%
TV	**89,6%**	**92,3%**	**98,0%**
Iron	94,4%	96,0%	98,0%
Vacuum cleaner	n.a.	n.a.	89,0%
Oven	**n.a.**	**59,6%**	**86,0%**
DVD player	n.a.	n.a.	68,0%
Hi-Fi	n.a.	n.a.	59,0%
Microwave oven	0,2%	9,8%	64,0%
PC	**n.a.**	**23,7%**	**64%**
Set top box	n.a.	n.a.	66,0%
VHS player	0%	45,4%	32,0%
Dishwasher	9,7%	21,6%	48,0%

Enquiry on appliances ownership (2/2)

Appliance	Diffusion 1985	Diffusion 1996	Diffusion 2012
Radio clock	n.a.	n.a.	46%
Internet (DSL)	n.a.	n.a.	46%
Air conditioner	0,6%	2,8%	41%
Multifunction printer	n.a.	n.a.	43%
Satellite decoder	n.a.	n.a.	32%
Video games	n.a.	n.a.	33%
Freezer	14,5%	27%	35%
Standard printer	n.a.	n.a.	28%
Alarm system	n.a.	n.a.	20%
Water heater	51,8%	34,6%	18%
Scanner	n.a.	n.a.	16%
Electric hob	n.a.	n.a.	15%
Tumble dryer	n.a.	n.a.	10%

Summary

Conclusions

- The knowledge of the residential load curves allows prediction on their consumption patterns;
- The effect of introduction of the mandatory ToU tariff on the residential load curves has been negligible from 2011 to 2012;
- The residential load curves have undergone substantial variations during the last years due to several factors:
  - variation in residential users' consumption habits, which have lead to an increase of consumption during evening and night hours;
  - variation in the number and types of the electric appliances in their homes: the decrease in the diffusion of electric boilers has been accompanied by the growing diffusion of consumer electronics.
- It is interesting to see how the residential load curves will be affected by future **demand-response** policies.

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