



## The Friulan adventures of Nardinix and his 3 queens



Nardinix



Antonella



Patrizia



Damiana





# ING-IND/17 Research Team

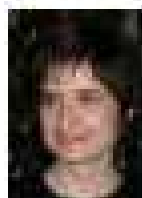


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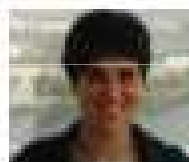


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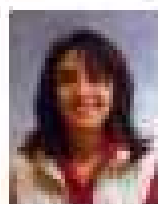


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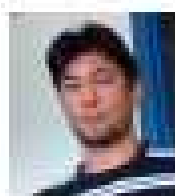


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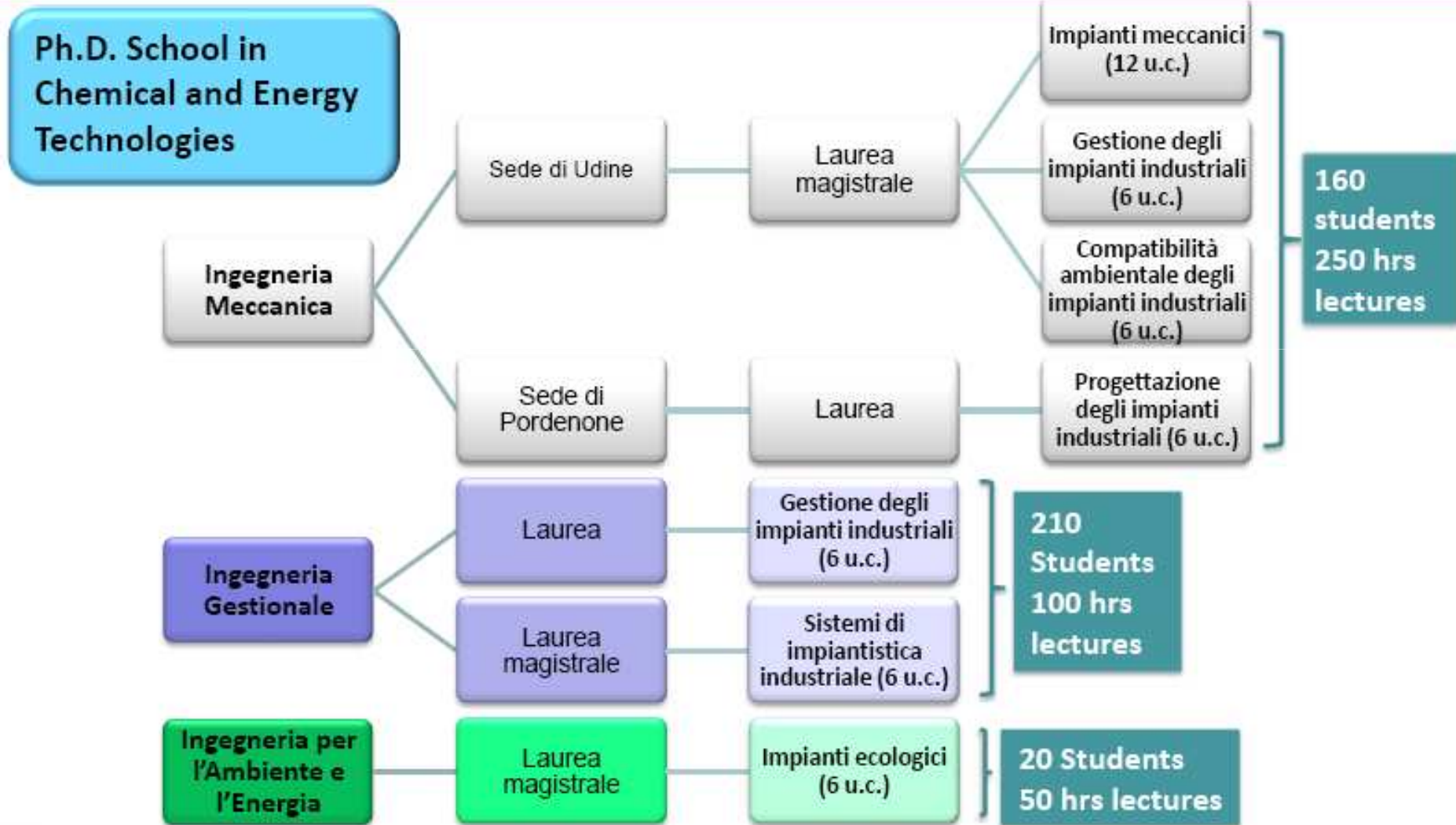
Udine



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# Teaching activity





# Facilities design

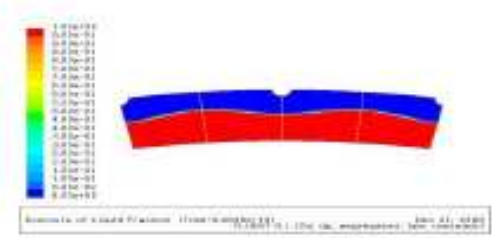
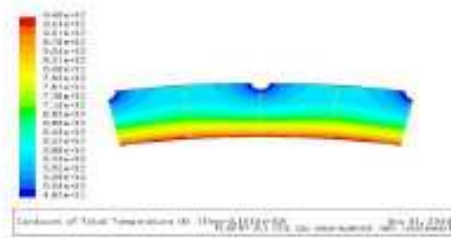
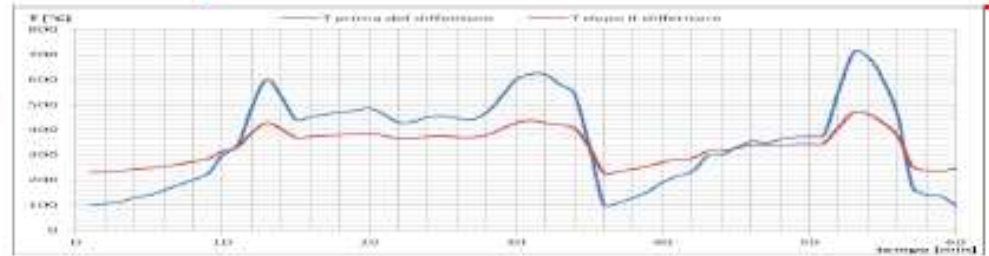
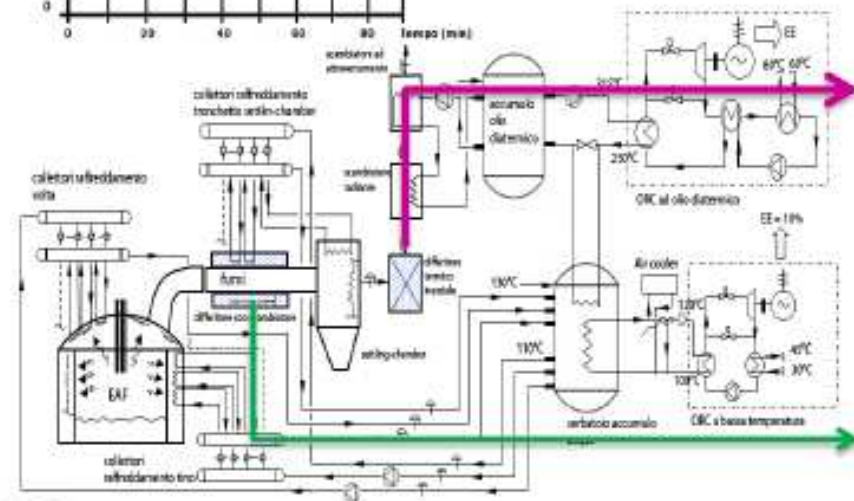
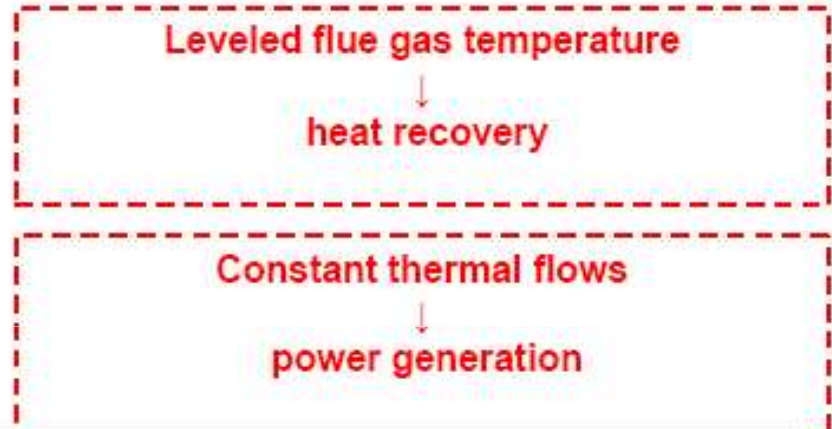
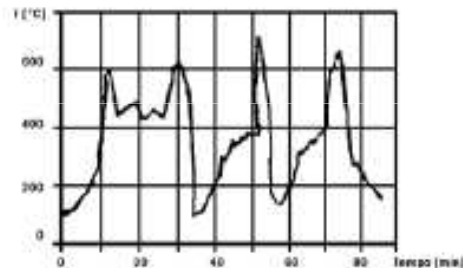
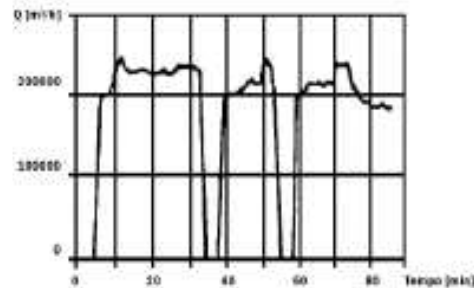
## Waste-to-energy plants for industrial districts





# Facilities design

## Steel industry application





# Distributed and district energy concepts in industrial districts

## Distributed heat recovery and exploitation concepts in industrial districts

*Optimal capacity and long term unit commitment planning of multi-source district heating systems by means of Mixed Integer Linear Programming (MILP) models*

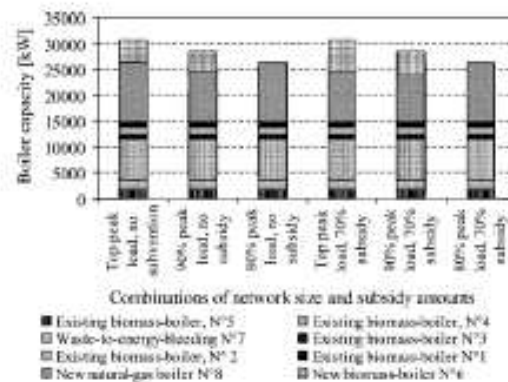


Fig. 4. Selected units and capacities at various subsidy levels for different network sizes.

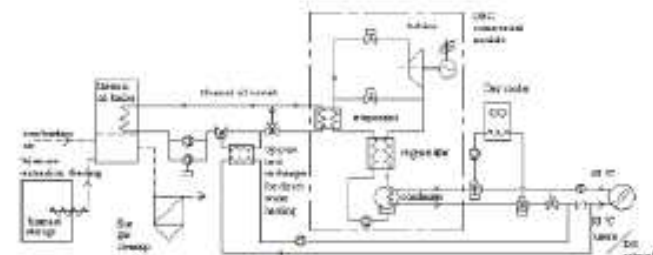
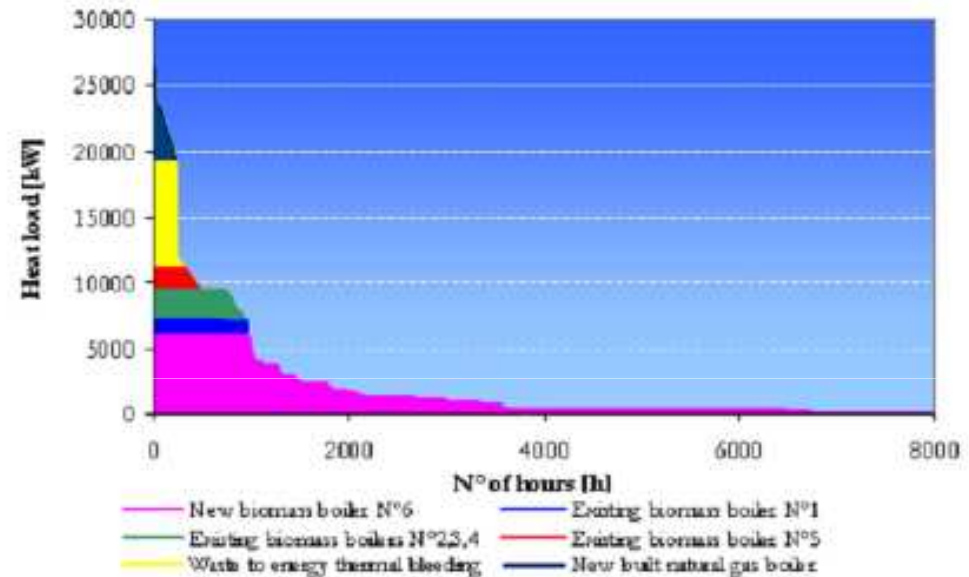


Figure 1. Organic Rankine Cycle for biomass-based power generation.

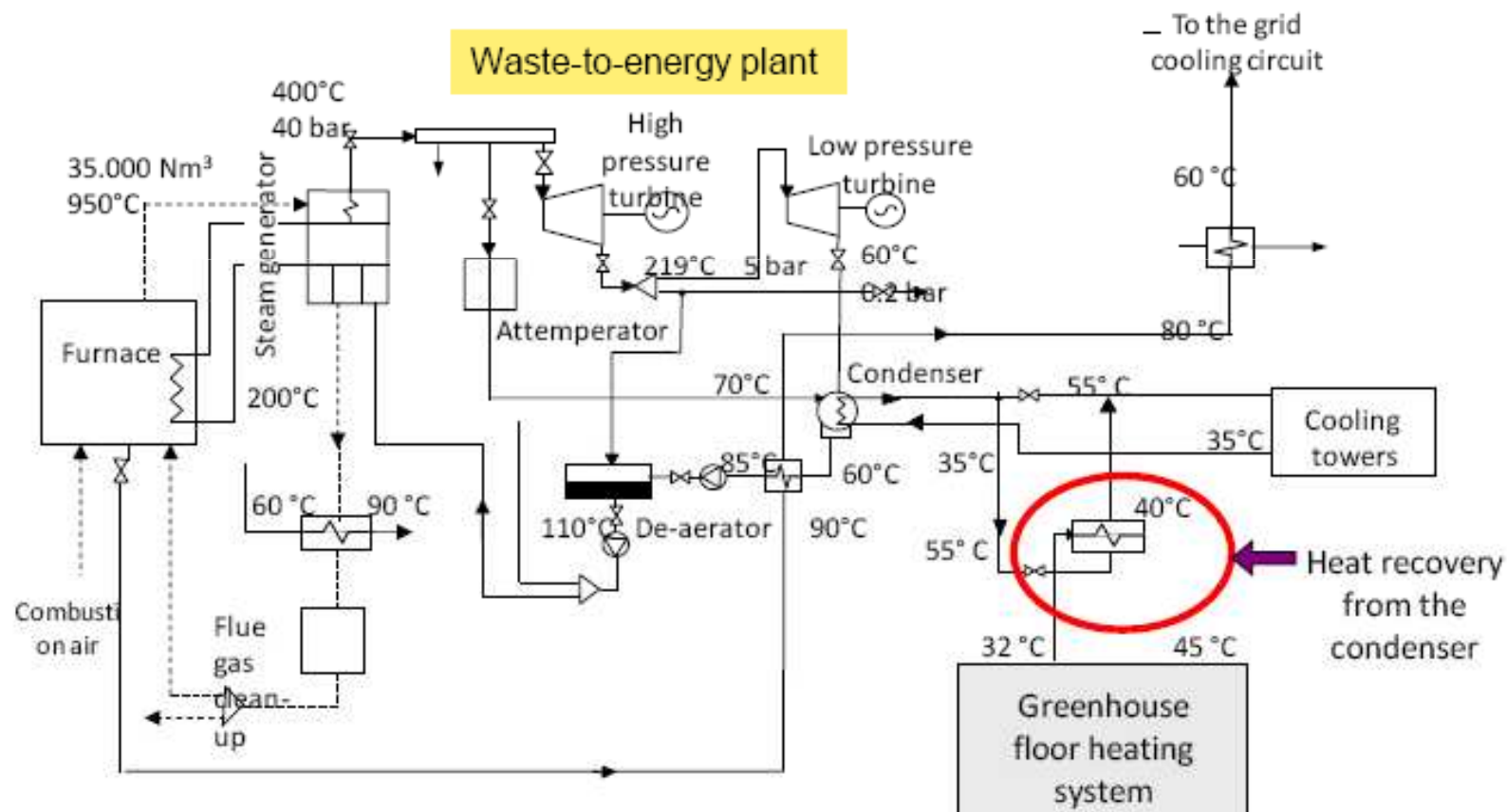






# Energy recovery

Optimization models to analyze conditions for profitable combination of different facilities to exploit unused energy flows

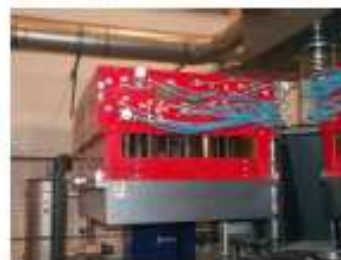
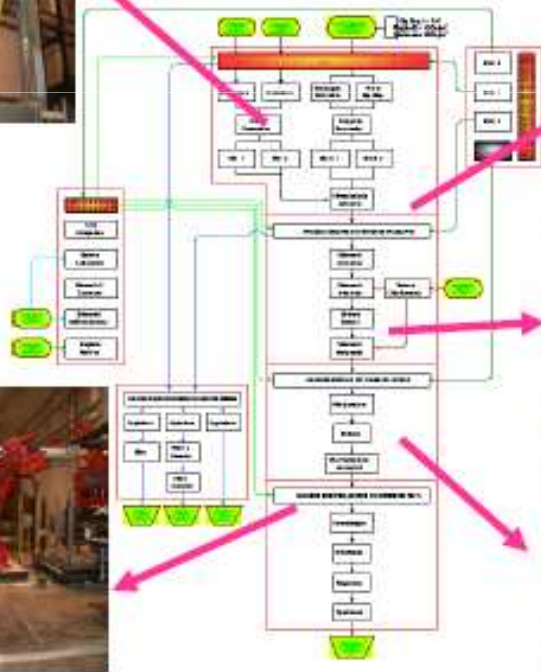




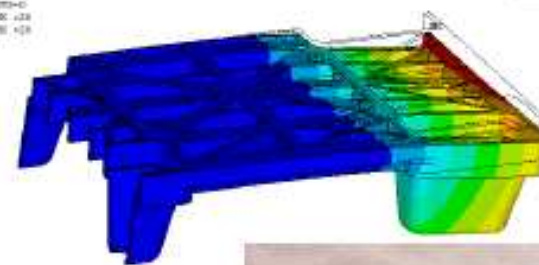


# Materials conversion optimisation

## Engineering of innovative processes for products from recycled plastics



Plastic-waste: 46% HDPE;  
3,6% PET; 2,5% PP; 2%  
LDPE film; Wood-waste: 45%



Plastic-waste:  
25% HDPE;  
5% PET;  
15% PP;  
50% LDPE





# Design of Biofuel Supply Chains

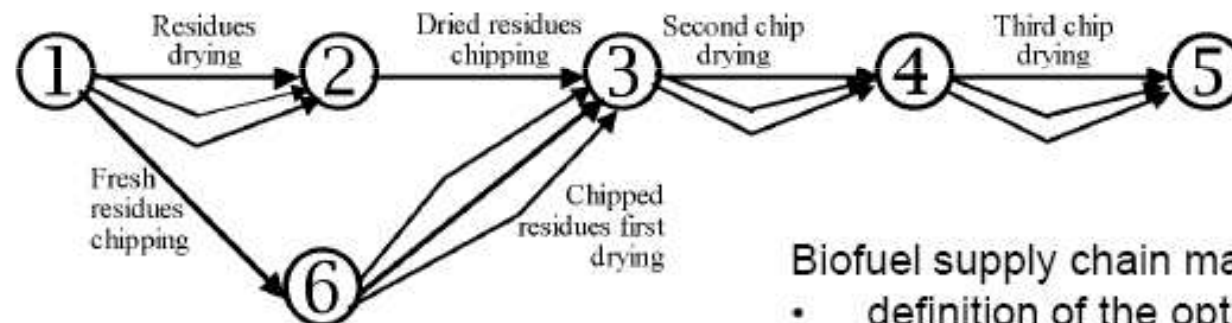
State 1	
Water content [%]	55%
Bulk density [kg/m <sup>3</sup> ]	554
Heating value (wet basis) [kWh/kg]	1.97
Energy density (wet basis) [kWh/m <sup>3</sup> ]	1093

State 2	
Water content [%]	40%
Bulk density [kg/m <sup>3</sup> ]	416
Heating value (wet basis) [kWh/kg]	2.86
Energy density (wet basis) [kWh/m <sup>3</sup> ]	1188

State 3	
Water content [%]	40%
Bulk density [kg/m <sup>3</sup> ]	224
Heating value (wet basis) [kWh/kg]	2.86
Energy density (wet basis) [kWh/m <sup>3</sup> ]	640

State 4	
Water content [%]	30%
Bulk density [kg/m <sup>3</sup> ]	192
Heating value (wet basis) [kWh/kg]	3.45
Energy density (wet basis) [kWh/m <sup>3</sup> ]	662

State 5	
Water content [%]	25%
Bulk density [kg/m <sup>3</sup> ]	180
Heating value (wet basis) [kWh/kg]	3.74
Energy density (wet basis) [kWh/m <sup>3</sup> ]	673



State 6	
Water content [%]	55%
Bulk density [kg/m <sup>3</sup> ]	299
Heating value (wet basis) [kWh/kg]	1.973
Energy density (wet basis) [kWh/m <sup>3</sup> ]	590



Biofuel supply chain mathematical models:

- definition of the optimal supply area and selection of proper transport paths;
- design of the operative chain (logical operations sequence and physical location of facilities);
- sizing of facilities, considering economies of scale.





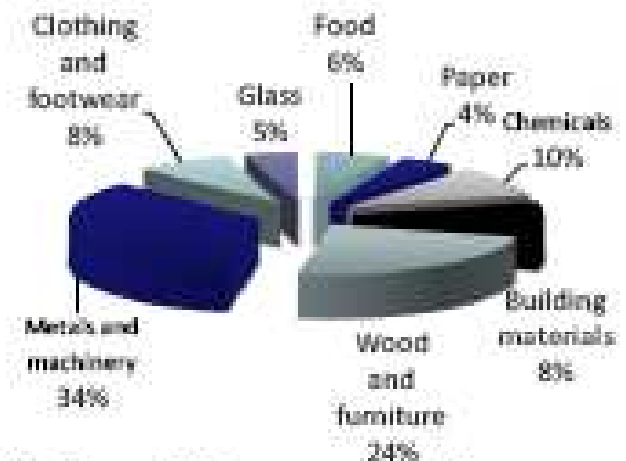
# Maintenance management in manufacturing firms

What's the status of maintenance management in North-Eastern Italy (2007)?

How far do size and context affect maintenance strategies and performance?



Sample of 100 manufacturing firms: composition (Industrial sectors)



Findings: Maintenance performance hardly seems a matter of size, while many elements of strategy certainly are. Most effective and size independent measures are enhanced preventive maintenance and condition based maintenance

Future work: In cooperation with

Strategic Decision		Operational size Correlation or dependence is verified?		Manufacturing sector Correlation or dependence is verified?		Operational Size Correlation or dependence is verified?		Maintenance performance				
		Statistical test used		Statistical test used		Statistical test used		Availability	Cost	Quality	Safety	Statistical test used
Capacity	Internal operations	Yes*	$\rho$	No	K-W	Yes*	$\rho$	No	Yes*	Yes*	Yes*	$\rho$
Facilities	Value of spare parts stock	Yes*	$\rho$	No	K-W	Yes*	$\rho$	No	No	Yes*	No	$\rho$
Technology	Presence of CIM	No	SW	No	$\chi^2$	Yes*	M-W	No	Yes*	Yes*	Yes*	SW
	Presence of a CMMS	Yes**	SW	Yes*	$\chi^2$	No	M-W	No	No	No	No	SW
Maintenance strategies	Optimizing type	Yes*	$\rho$	No	K-W	No	$\rho$	No	No	No	No	$\rho$

Notes: \*verified at  $p < 0.05$ ; \*\*verified at  $p < 0.01$  for the number of employees only;  $\rho$  = Spearman's rank-based correlation; M-W = Mann-Whitney U-test; SW = Kruskal-Wallis Test





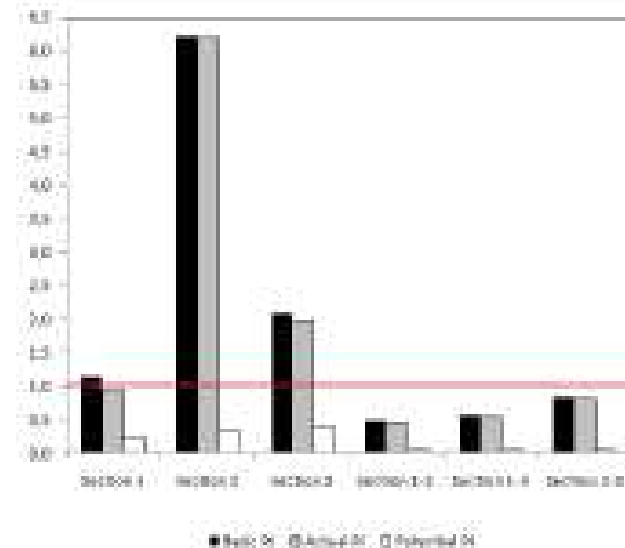
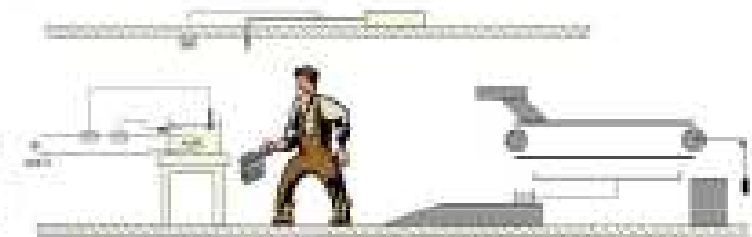
# System safety engineering

## Development of new methodologies for OHS assessment in SMEs

### RATE analysis

Risk matrix

Scenario	Event Type	Scenario 1			Scenario 2				Scenario 3				
		100	1000	10000	1000	10000	100000	1000000	10000000	100000000	1000000000	10000000000	
Scenario 1	Emergency stop												
	Start												
	Emergency stop												
Scenario 2	Start												
	Stop												
	Emergency stop												
Scenario 3	Start												
	Stop												
	Emergency stop												





# Sustainable Automated Storage and Retrieval Systems

The traditional perspective



Picking time minimization

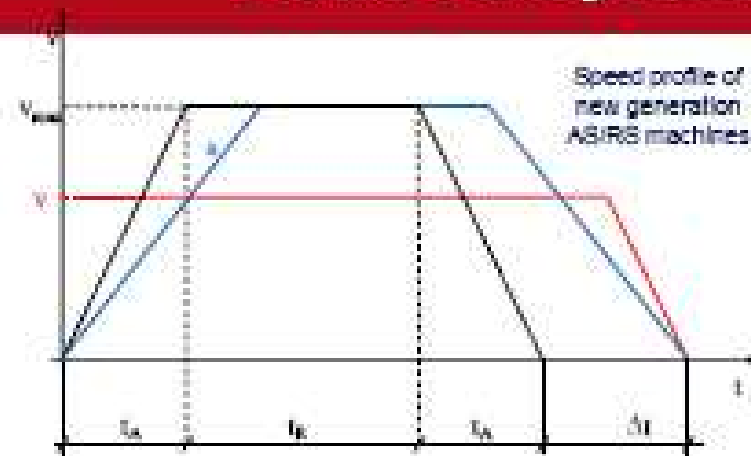
The new sustainable perspective



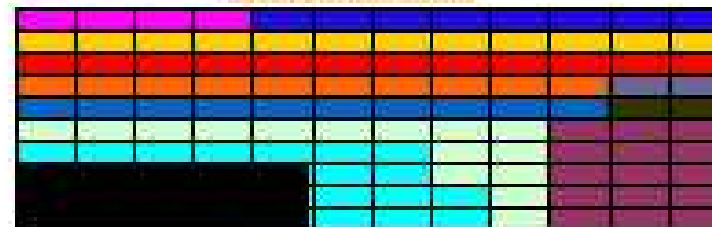
Energy-based optimization



Antonella Meneghetti is the winner of the Burdige Award 2010 for the paper "Sustainable storage assignment in AS/RSs"



Time-based allocation



Rectangular or L-shape zones

Energy-based allocation



Stepwise shape zones





# Top 10 publications (per ING-IND/17 topic)

Authors	Title	Journal, Conference, Publisher	Year - pp	Research Topic
Meneghetti, Nardin, Simeoni	Waste-to-energy applications in an industrial district	Applied Energy	2002, N. 1, Vol. 72, pp. 443 - 463	1
Nardin, Gaudio, Antonel, Simeoni	Impiantistica enologica. Ciclo tecnologico di vinificazione e progettazione degli Impianti	■ Sole 24 ore - Edagricole	2008	1
Chinese, Meneghetti, Nardin	Diffused introduction of Organic Rankine Cycle for biomass-based power generation in an industrial district: a systems analysis	Int. Journal of Energy Research	2004, N. 28, pp.1003-1021	2
Chinese, Meneghetti, Nardin, Simeoni	From hospital to municipal cogeneration systems: an Italian case study	Int. Journal of Energy Research	2007, N.9, Vol.31, pp. 829-848	2
Chinese, Nardin, Sara	Multicriteria analysis for the selection of space heating systems in an industrial building	Energy	2011, N. 1, Vol.36, pp. 556-563	2
Chinese, Meneghetti, Nardin	Waste-to-energy based greenhouse heating: exploring viability conditions through optimisation models	Renewable Energy	2005, N.10, Vol.30, pp. 1573-1586	3
Pantansli, Meneghetti Bianco, Linuzzi	Developing a new methodology for OHS assessment in small and medium enterprises	Proceedings of ESREL 2008 , Taylor & Francis Group	2009, pp. 2727-2734	4
Chinese, Ghirardo	Maintenance management in Italian manufacturing firms. Matters of size and matters of strategy	Journal of Quality in Maintenance Eng.	2010, vol. 16(2), pp.156-180,	5
Chinese, Meneghetti	Design of Forest Biofuels Supply Chains	Int. J. of Logistics Systems and Management	2009, Vol. 5, pp. 523-550	6
Meneghetti	Sustainable storage assignment in AS/RS (Burbidge award for the best paper at APMS 2010)	IFIP-AICT Series, Springer Verlag	2011, forthcoming	7

## Research Topics – Ing/Ind-17

1	2	3	4	5	6	7
Production system analysis and design	Auxiliary plant analysis and design	Processes and production technologies	Ergonomic and safety of industrial systems	Production system management	Logistics	Production system automation



# RESEARCH PROJECT INDUSTRIAL PARTNERS

## RESEARCH PROJECTS (2007-2011): PUBLIC FUNDING

Project	Year	Area	Description
RF	2010	1	"Zero CO <sub>2</sub> " project– Optimal sizing of a mixed (renewable/non renewable) power plant
RF	2009	2	Facilities optimisation and energy savings in regional healthcare system
RF	2008	2	Renewable energy production planning in Friuli Venezia Giulia
Municipality of Udine	2007	2	Feasibility study of a CHP plant for Udine hospital with district heating for Udine municipality and university.

## RESEARCH INDUSTRIAL PROJECTS (2007-2011): STRUCTURED PARTNERS

- ❑ Unione Industriali (Pordenone)
- ❑ Zignago Vetro S.p.A. (Fossalta di Protogruaro)
- ❑ Associazione Piccole e Media Industrie (Udine)
- ❑ NET S.p.A. (Udine)
- ❑ AMGA (Udine)
- ❑ Area Science Park (Trieste)
- ❑ Mondial Group (S. Giorgio Monferrato - AL)
- ❑ System Logistics (Fiorano – MO)
- ❑ Buzzi Unicem S.p.A. (Casale Monferrato – AL)
- ❑ Electronic Solar s.r.l. (Cappelletta di Noale - VE)
- ❑ Siderurgica s.r.l. (S. Giorgio di Nogaro - UD)
- ❑ Fire Energy (Conegliano – TV)
- ❑ Tersa srl (Monfalcone – GO)
- ❑ Gefri energia s.r.l. (Tarcento - UD)
- ❑ Deteco (Porcia – PN)
- ❑ EuroProgetti s.r.l. (UD)



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