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2nd International ecoinvent Meeting
Lausanne, March 14, 2008

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metals treatment and compressed air supply

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ESU-services Ltd.

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Contents

- Overview of processes analysed
- General modelling principles
- Description of life cycle inventories of machine processing
- Conclusions

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Overview of processes analysed

- Average machine processing
- Degreasing of metal surfaces
- Chipping
- Laser machining
- Chippless shaping
- compressed air supply

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Modelling principles: capital equipment

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- factory infrastructure:
  demand of a share of capital equipment included in all machining datasets
- exception “laser machining”:
  no factory hall demand included, as no correlation between machining hours and factory infrastructure
- exception “compressed air supply”:
  considered ancillary process (e.g., to metals machining) in a factory

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Modelling principles: Degreasing

- machining datasets do NOT include degreasing

  Reason:

  - machining is per mass (or time in the case of laser machinig)
  - degreasing is per surface
- “surface to mass” ratio must be known
- practitioner needs to add degreasing dataset to each individual machining dataset

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Modelling principles: Reference unit and material input

- chipping datasets:
  - per kg material removed
  - material removed is an input
- chipless shaping:
  - per kg material processed
  - no material input
- laser machining:
  - per hour processing
  - no material input (a few mg/sec)
- compressed air supply:
  - per m^3 comp. air supplied (including losses in the network)
  - per m^3 comp. air produced

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Average machine processing

- average product manufacturing:

  steel

  chromium steel

  aluminium

  copper

  metal (82.4/2.0/3.3/12.2 %)

- additional datasets:

  - machine (manufacturing)
  - machine operation
  - factory (construction)
  - factory operation
  - metal input

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Inventory data

- Data from 8 mechanical processing machines
- Average capacity about 8’000 tons
  from 44 to 210’000 tons capacity
- data from 2003 to 2006
- data includes
  - solvents, consumption
  - solvents, emission: 0.56g/kg metal product
  - lubricating oil
  - compressed air
  - thermal energy
  - electricity

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machine and factory

- manufacture data:
  based on the same 8 machines
- factory operation:
  ancillary energy consumption, water consumption and wastes generated
- metal working factory:
  - includes building hall and land use
  - data based on three manufacturers

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Degreasing of metals

- industry data from European household device manufacturer
- inventory data includes:
  - electricity
  - thermal energy
  - industrial cleaning detergents
  - sodium chloride
  - sulphuric acid
  - water

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Turning

- Two phases in treatment:
  roughing, dressing and average
- Two different technologies:
  conventional and CNC (Computerized Numerical Control)
- Five different metals:
  steel, NiCr-steel, cast iron, aluminium, brass
- Inventory data:
  - electricity
  - compressed air (CNC only)
  - lubricating oil (CNC only)
  - factory (operation and construction)
  - amount of metal removed

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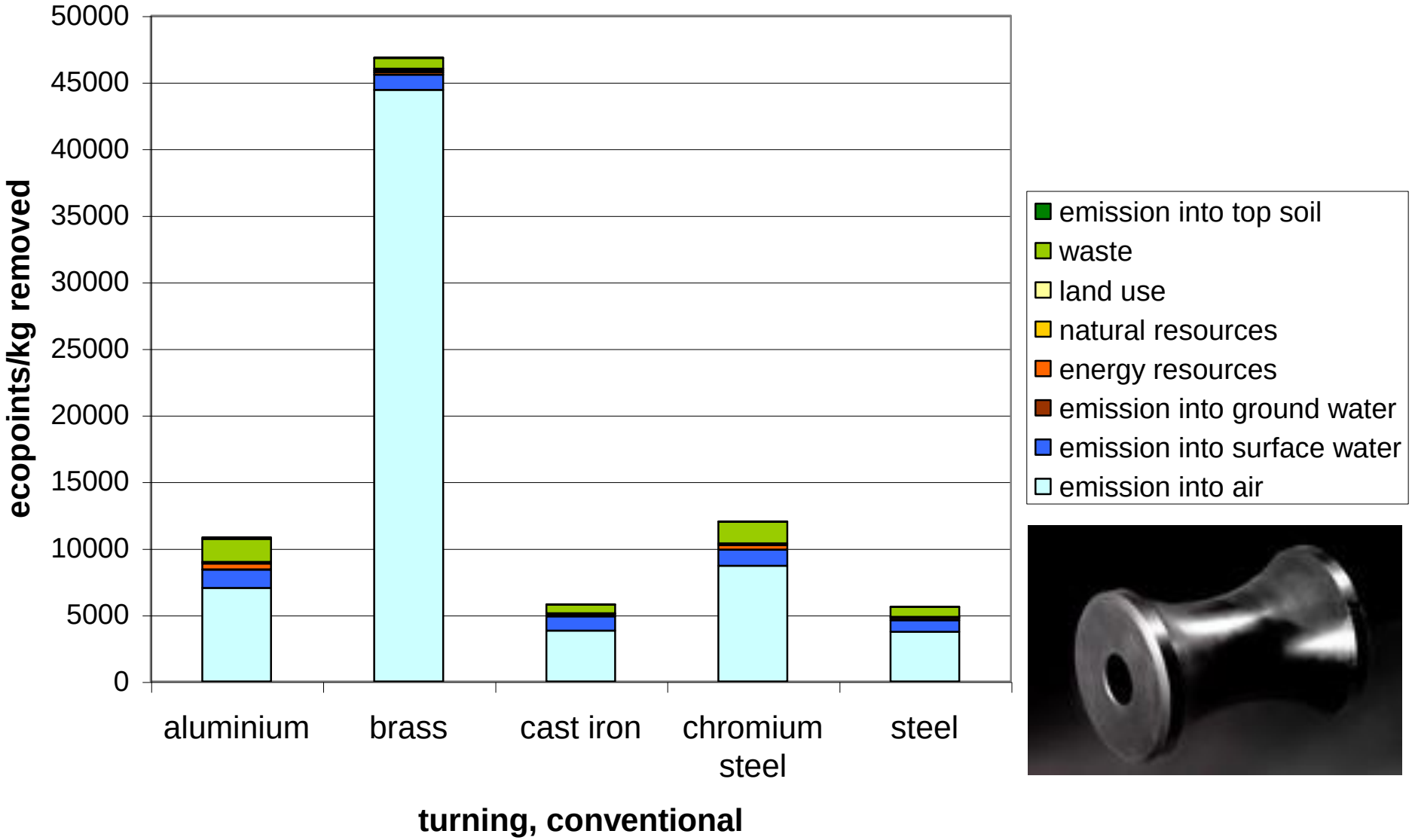
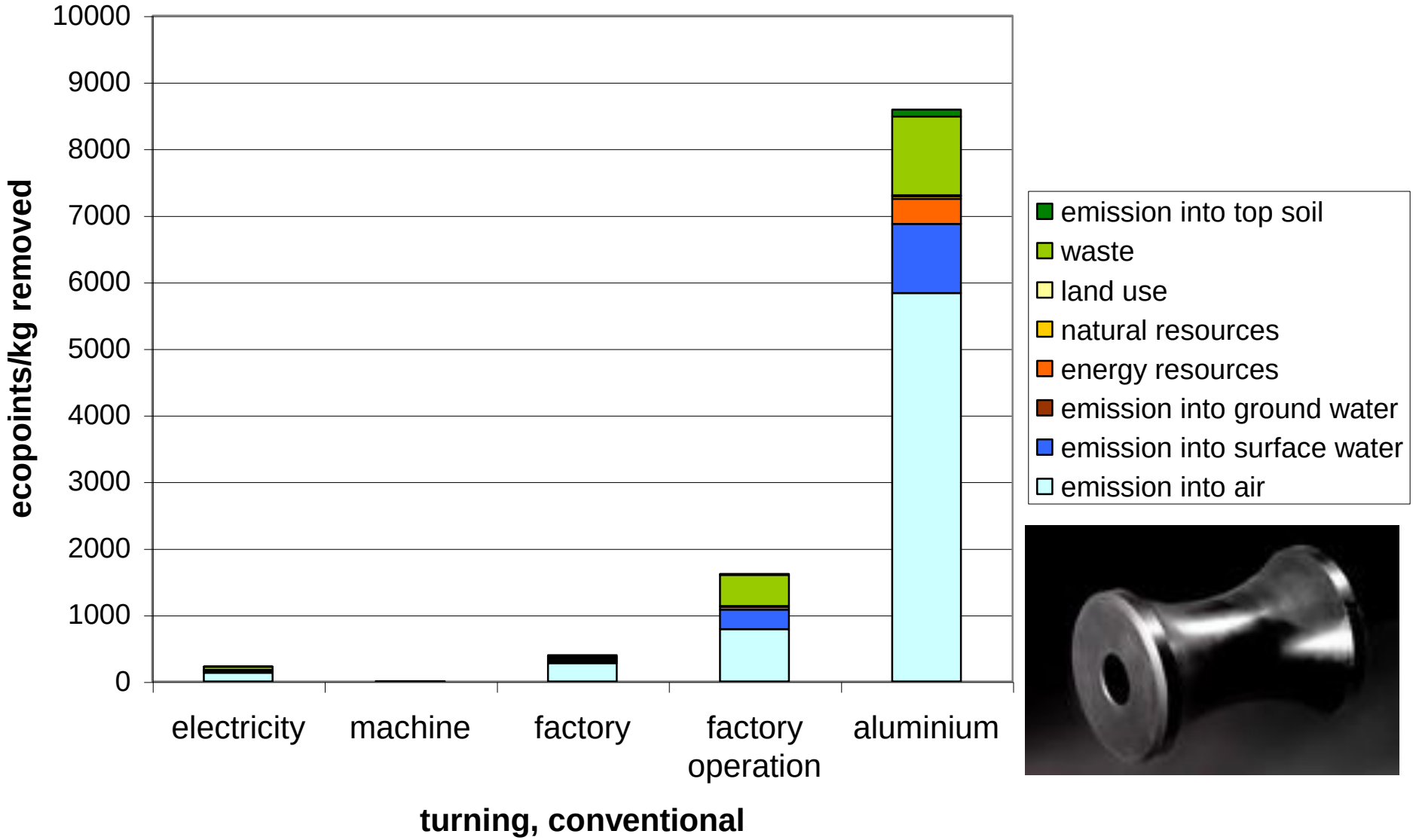
Results: ecological scarcity 06



Contributions: ecological scarcity 06



Drilling

- Two different technologies:
  conventional and CNC
- Five different metals:
  steel, chromium steel, aluminium, copper, brass
- Inventory data:
  - electricity
  - compressed air (CNC only)
  - lubricating oil (CNC only)
  - capital equipment
  - factory operation
  - amount of metal removed

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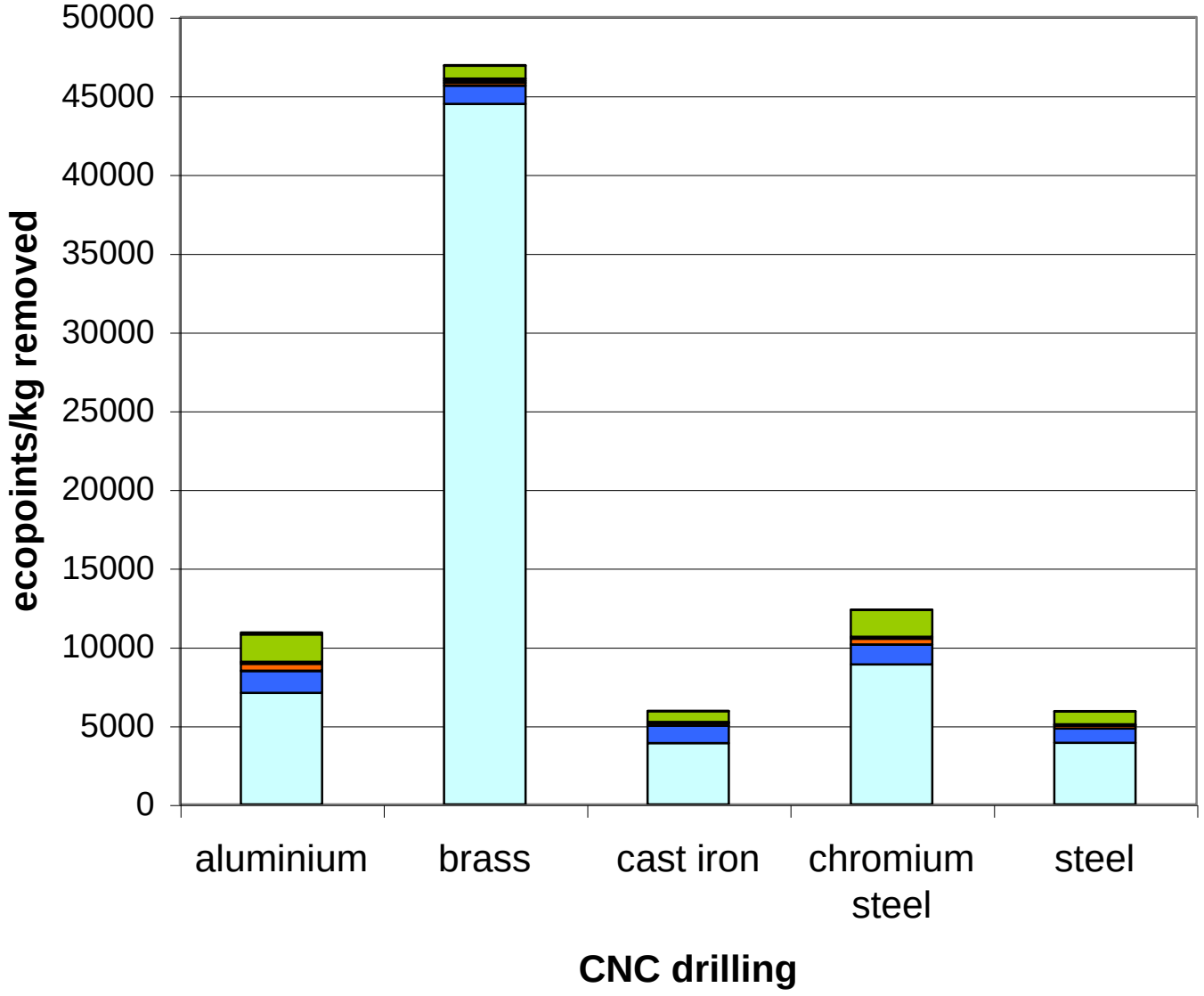
Results: ecological scarcity 06



Milling

- Four different process modes:
  large and small parts, dressing and average
- Four different metals:
  steel, chromium steel, cast iron, aluminium
- Inventory data:
  - electricity
  - compressed air
  - lubricating oil
  - amount of metal removed

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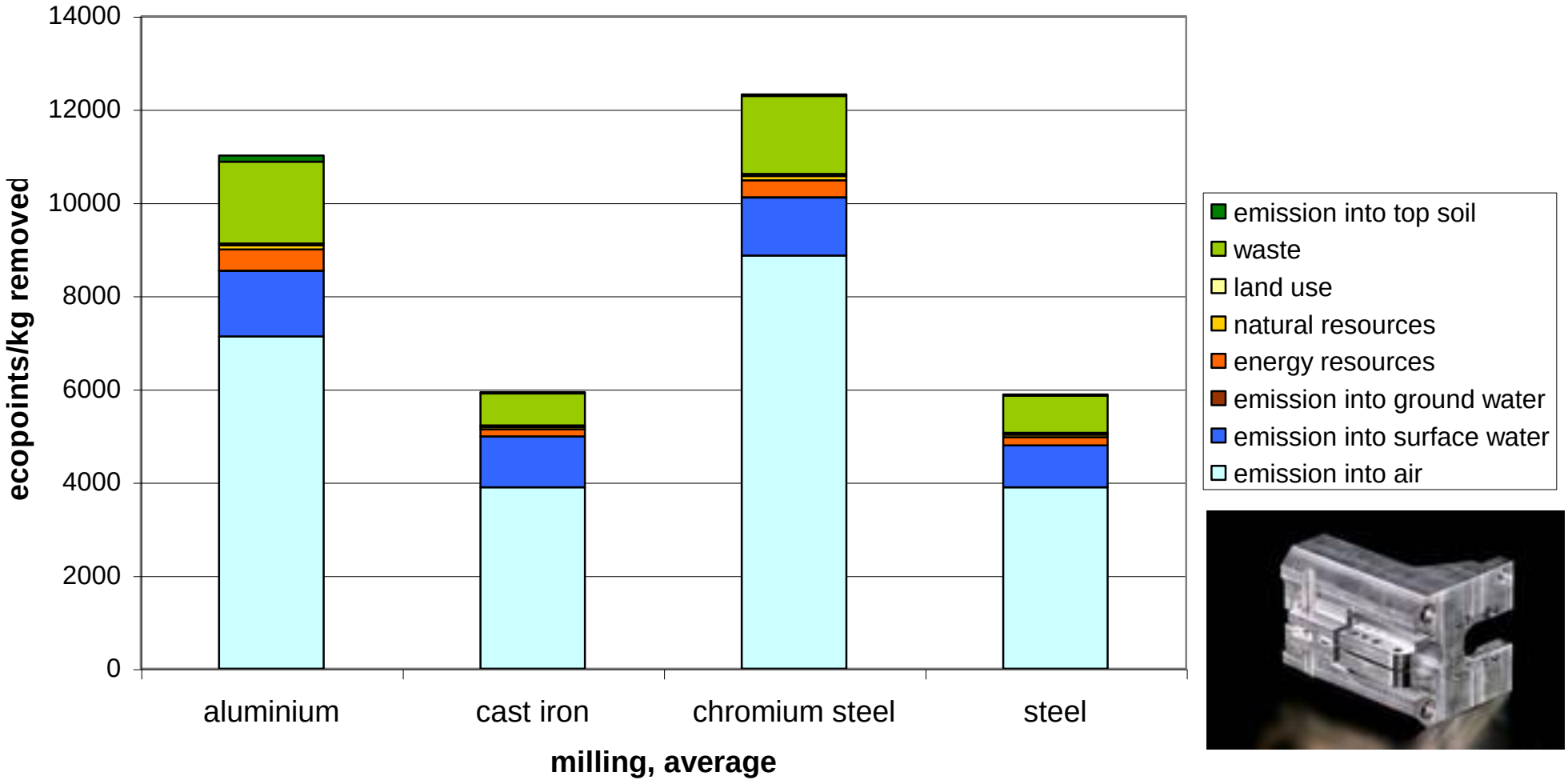
Results: ecological scarcity 06



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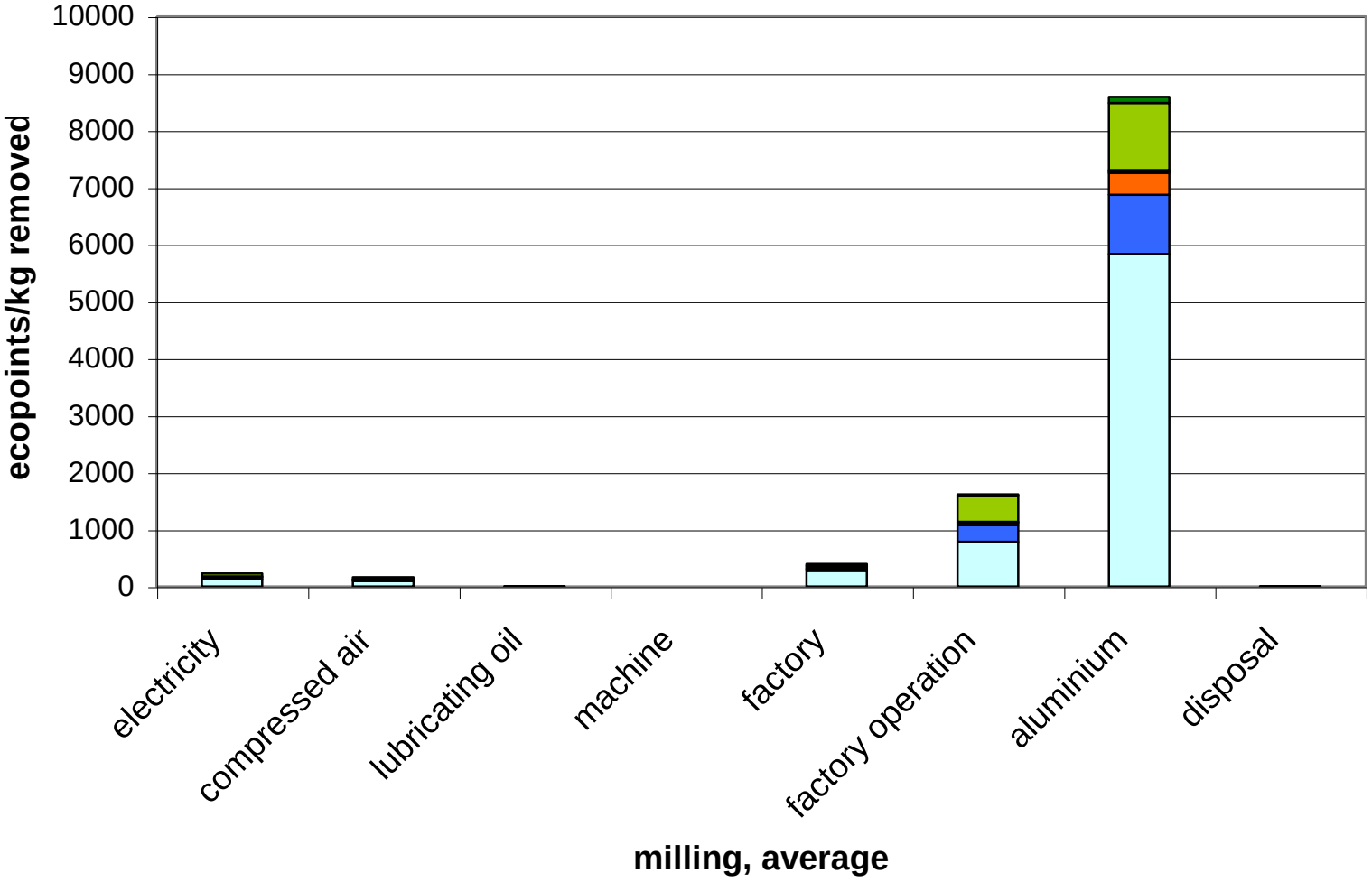
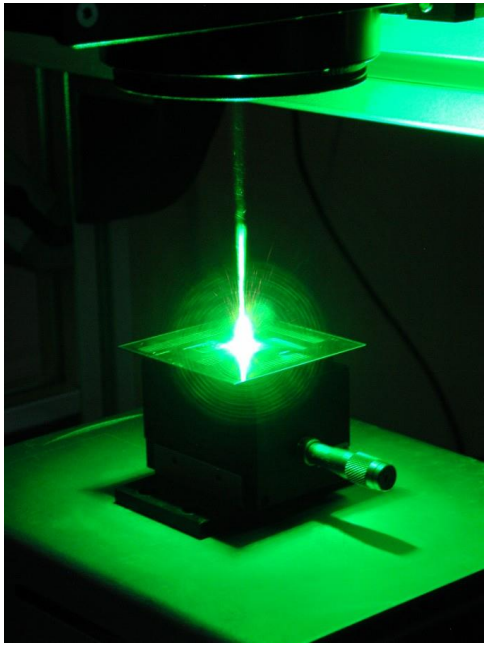


Laser machining of metals

- Two different laser systems:
  - YAG (Yttrium-Aluminium garnet)
  - CO_2
- Different laser sizes:
  - YAG: 30, 40, 50, 60, 120, 200, 330, 500 W
  - CO_2: 2, 2.7, 3.2, 4.0, 5.0, 6.0 kW
- Total operation time:
  - YAG: 2 hours/day; 5 days/week; 15 years
  - CO_2: 12 hours/day; 5 days/week; 15 years



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Laser machining: inventory data

- YAG laser systems:
  - electricity
  - cooling water (larger units only)
  - air emissions of particulates, NO_X, and ozone
  - machine manufacture
- CO_2 laser systems:
  - electricity
  - industrial gases (helium, nitrogen, carbon dioxide)
  - air emissions of helium, particulates, NO_X, CO_2, and ozone
  - machine manufacture

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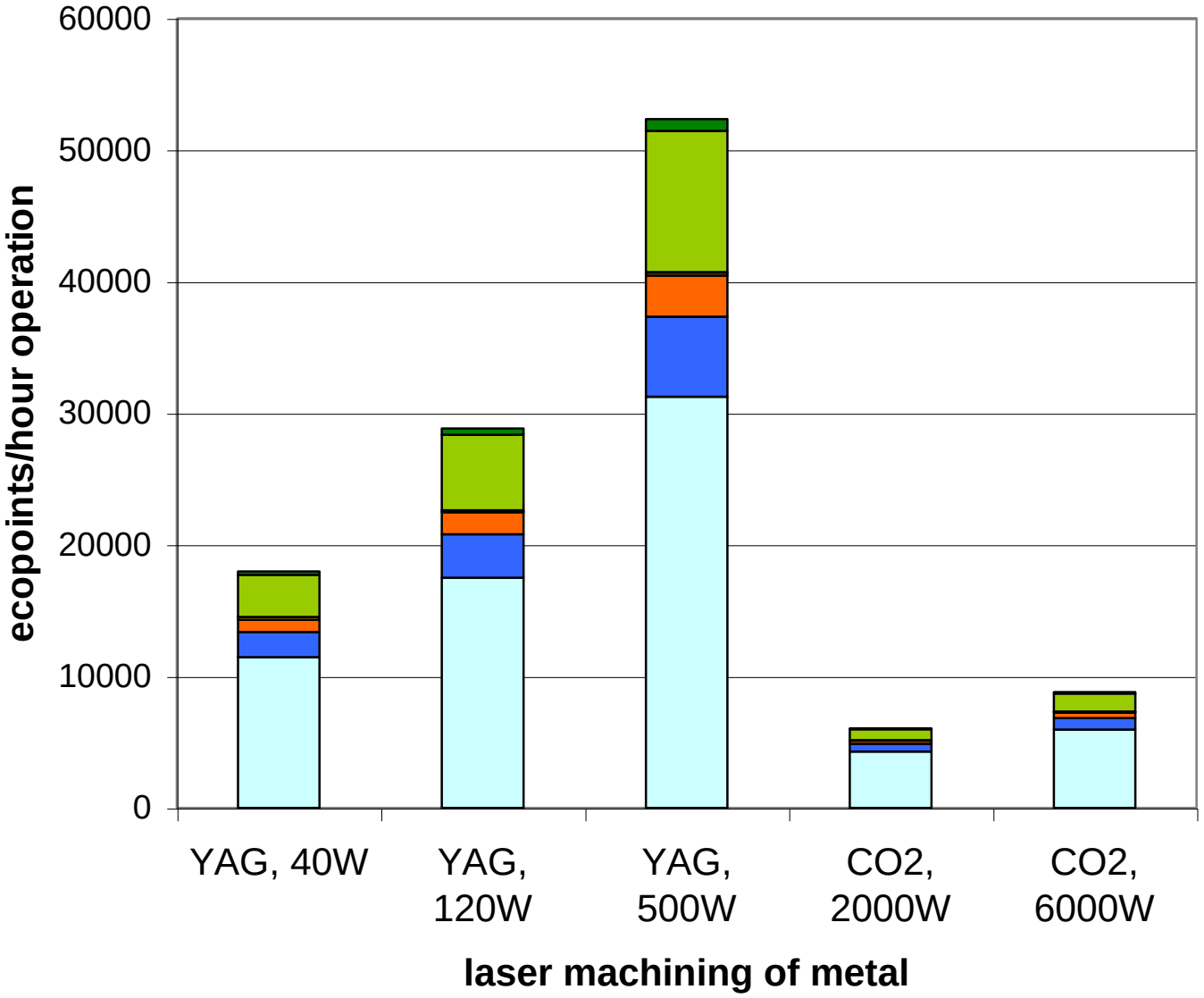
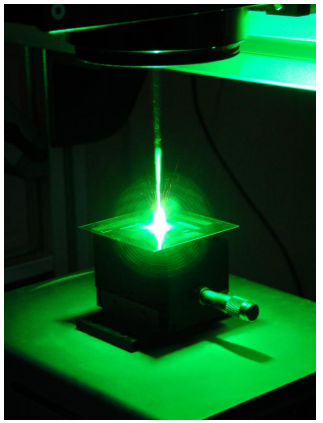
Results: ecological scarcity 06





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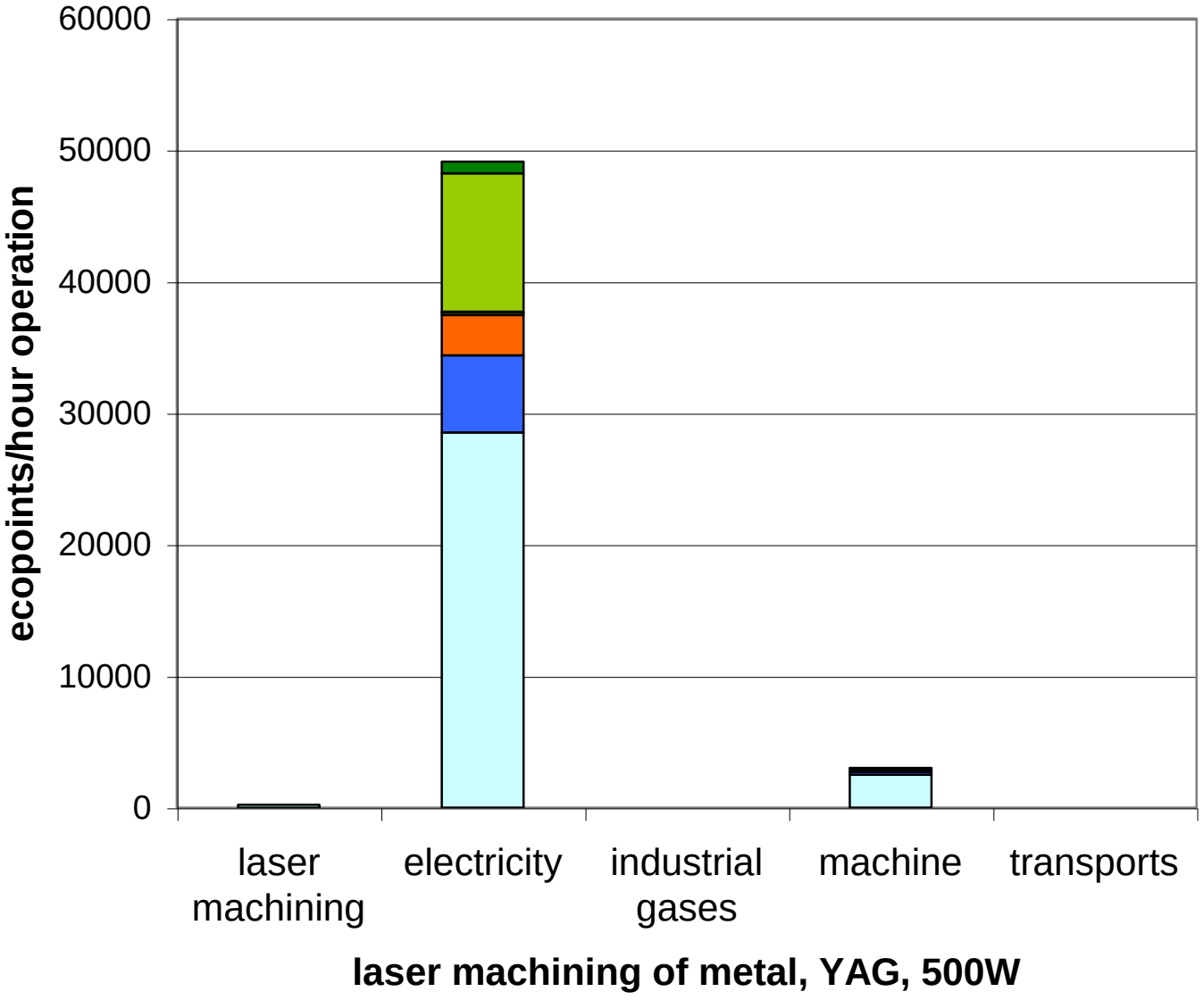

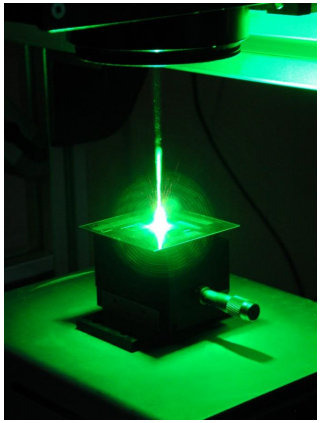

Impact extrusion

- Three different levels of temperature:
  cold ($T/T_{melt} < 0.3$), warm, hot ($T/T_{melt} > 0.6$)
- two different metals:
  - steel
  - aluminium (cold IE only)
- Datasets on
  - surface treatment (cold IE only)
  - warming (warm/hot IE only)
  - deformation stroke
  - 1 to five stroke treatments
- Inventory data:
  energy inputs, capital equipment and factory operation

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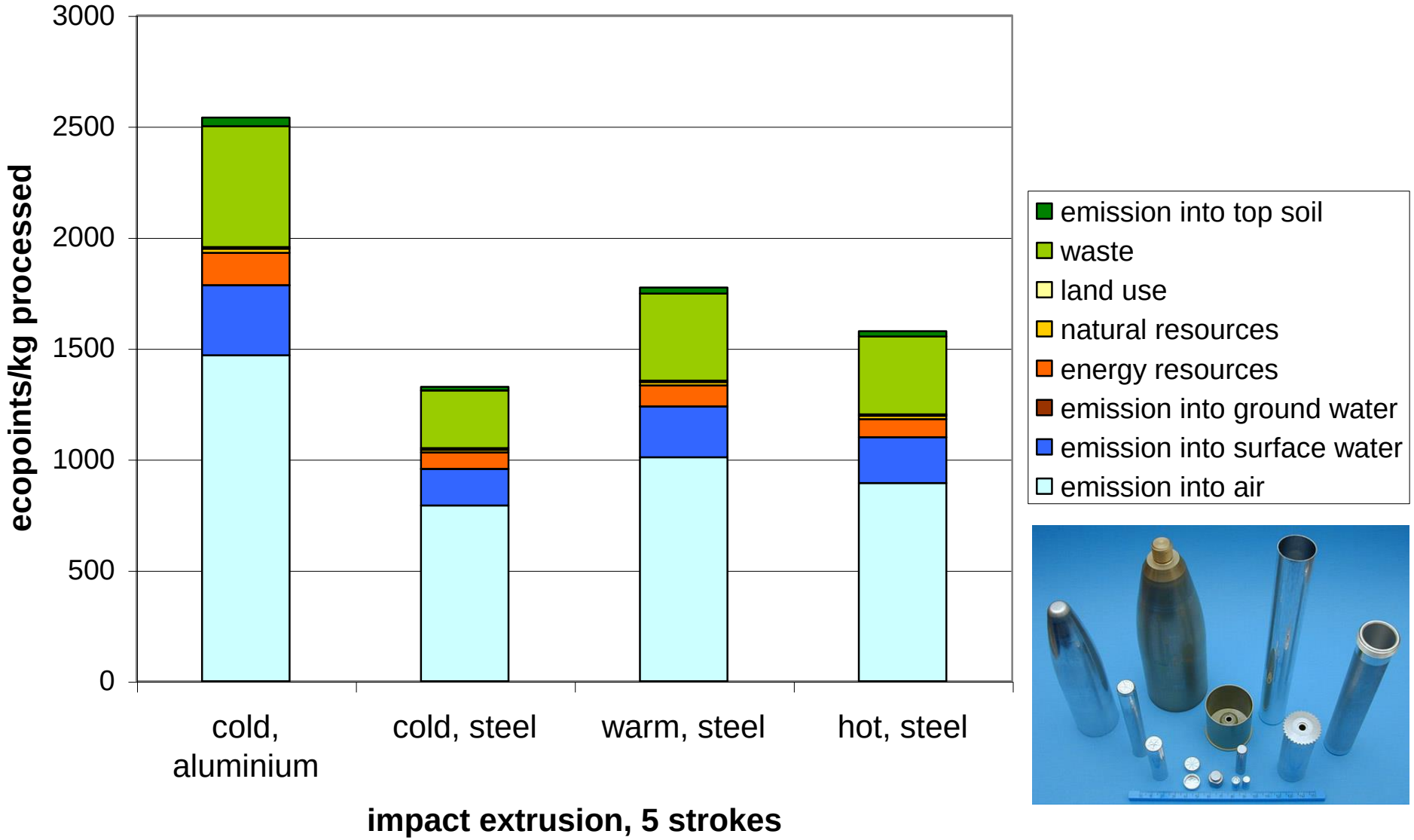
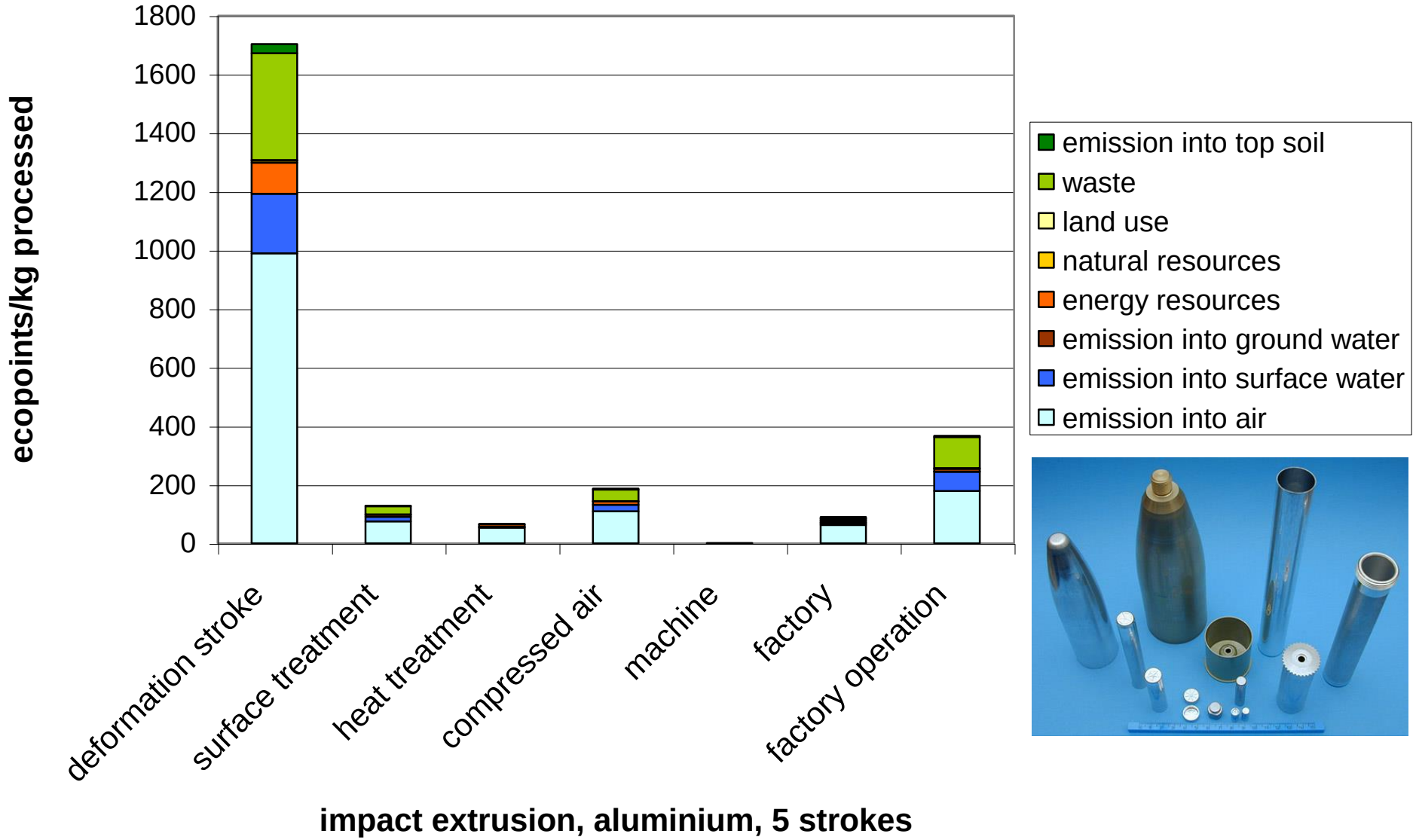
Results: ecological scarcity 06



Contributions: ecological scarcity 06



Deep drawing

- Two different modes:
  single stroke and continuous
- Different press sizes:
  650, 3’500, 10’000, 38’000 kN
- one metal: steel
- Inventory data:
  - electricity,
  - compressed air
  - capital equipment
  - factory operation

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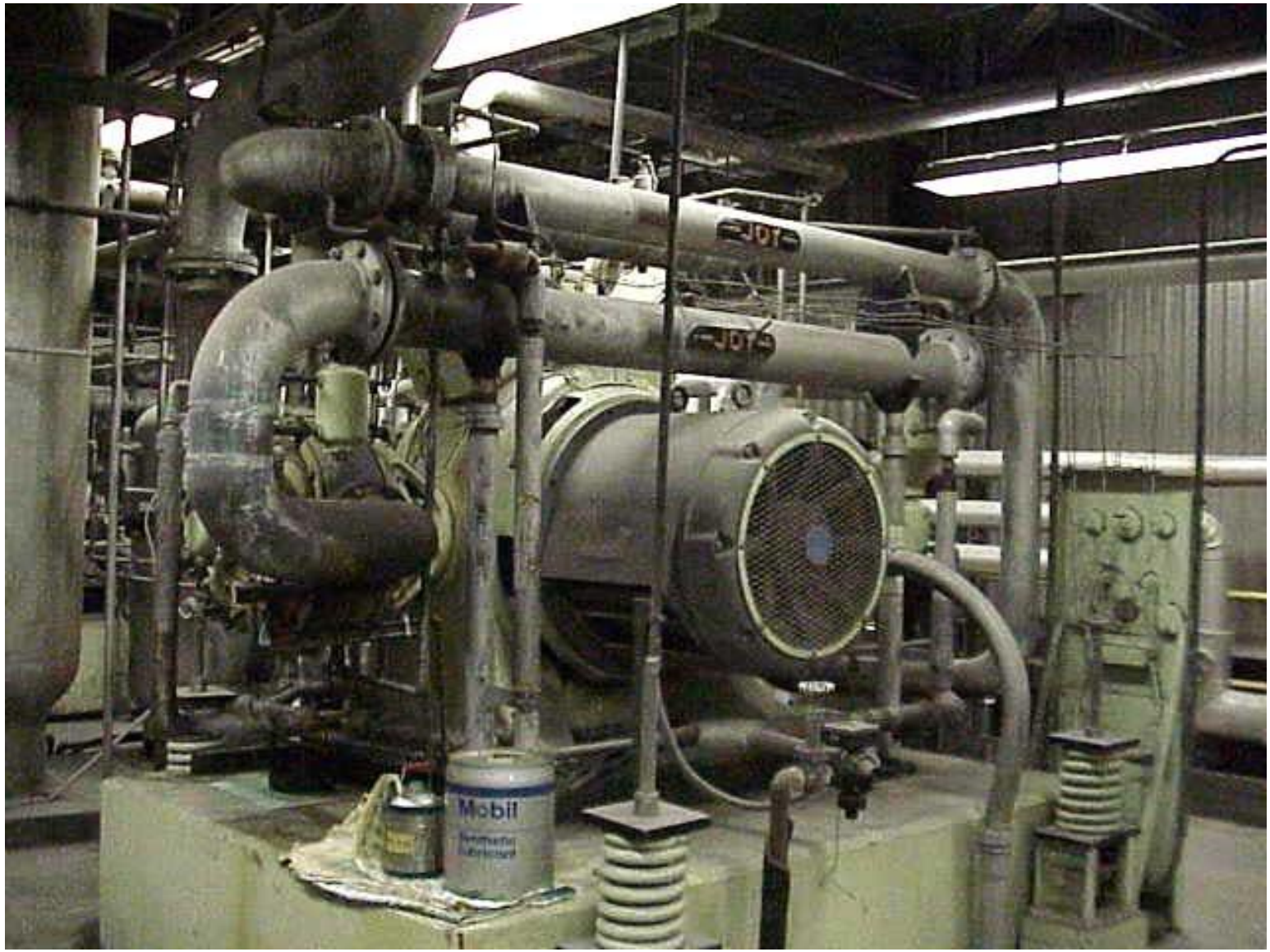
Compressed air supply



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Compressed air supply system

- compressor
- compressed air storage container (opt.)
- dryer (opt.)
- filter (opt.)
- pipe network (for distribution)
- consumer devices

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Drivers of electricity consumption

- leakage rate
- pressure level
- appropriateness of control settings
- size of compressor

increase in electricity consumption due to filter and dryer:

- small installations: 5 %
- large installations: 3 %

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Compressors installed in Switzerland

	power in kW				
	<3	3-15	18-90	>90	total
installed compressors	110‘000	30‘000	8‘000	800	148‘000
	74 %	*20 %*	*5 %*	*1 %*	
electricity consumption [GWh]	11	150	400	200	671
	1 %	*20 %*	*53 %*	*26 %*	

Key figures compressors & network

- life time: 15 years
- 750 hours per year
- machine weight:
  4 kW: 140 kg (35 kg/kW)
  300 kW: 4600 kg (15 kg/kW)
- increase in electricity consumption due to filter and dryer:
  - small installations: 5 %
  - large installations: 3 %
- pipe diameter: 100 mm
- network length: 4’500 m
- 100 mg steel (large), 34 mg aluminium (small) per Nm^3

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Datasets available

- Two different compressor sizes:
  <30 kW, >30 kW
- Three different pressure levels:
  - <30 kW: 8, 10, 12 bar
  - >30 kW: 6, 7, 8 bar
- Three different technology levels:
  - average
  - optimised
  - best generation (>30 kW only)

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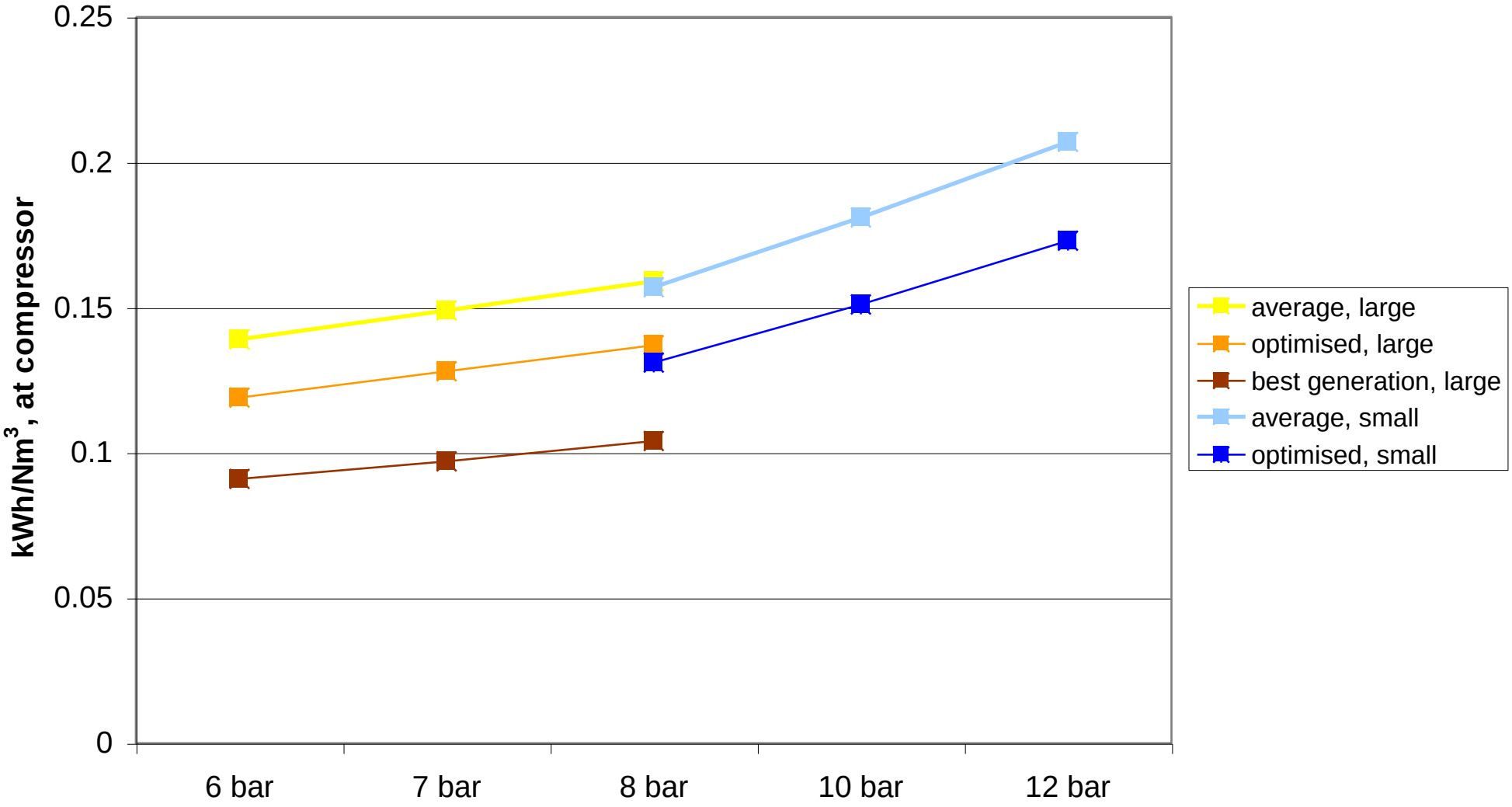
Electricity consumption



Inventory data

- leakage rate > 30 kW:
  - average: 30 %
  - optimised: 15 %
  - best generation: 10 %
- leakage rate < 30 kW:
  - average: 50 %
  - optimised: 5 %
- lubricating oil:
  - small: 10 mg / Nm^3
  - large: 2.1 mg / Nm^3

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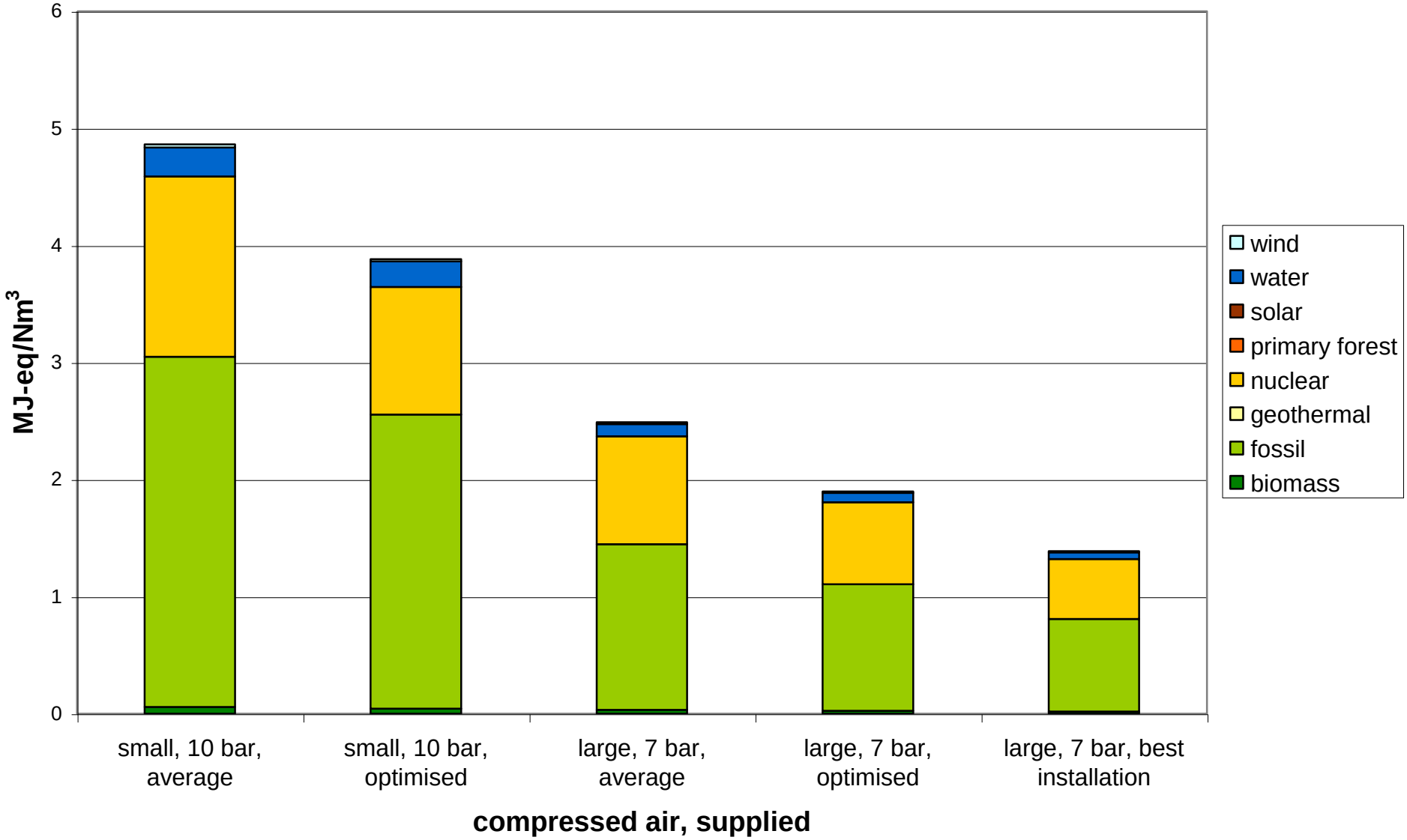
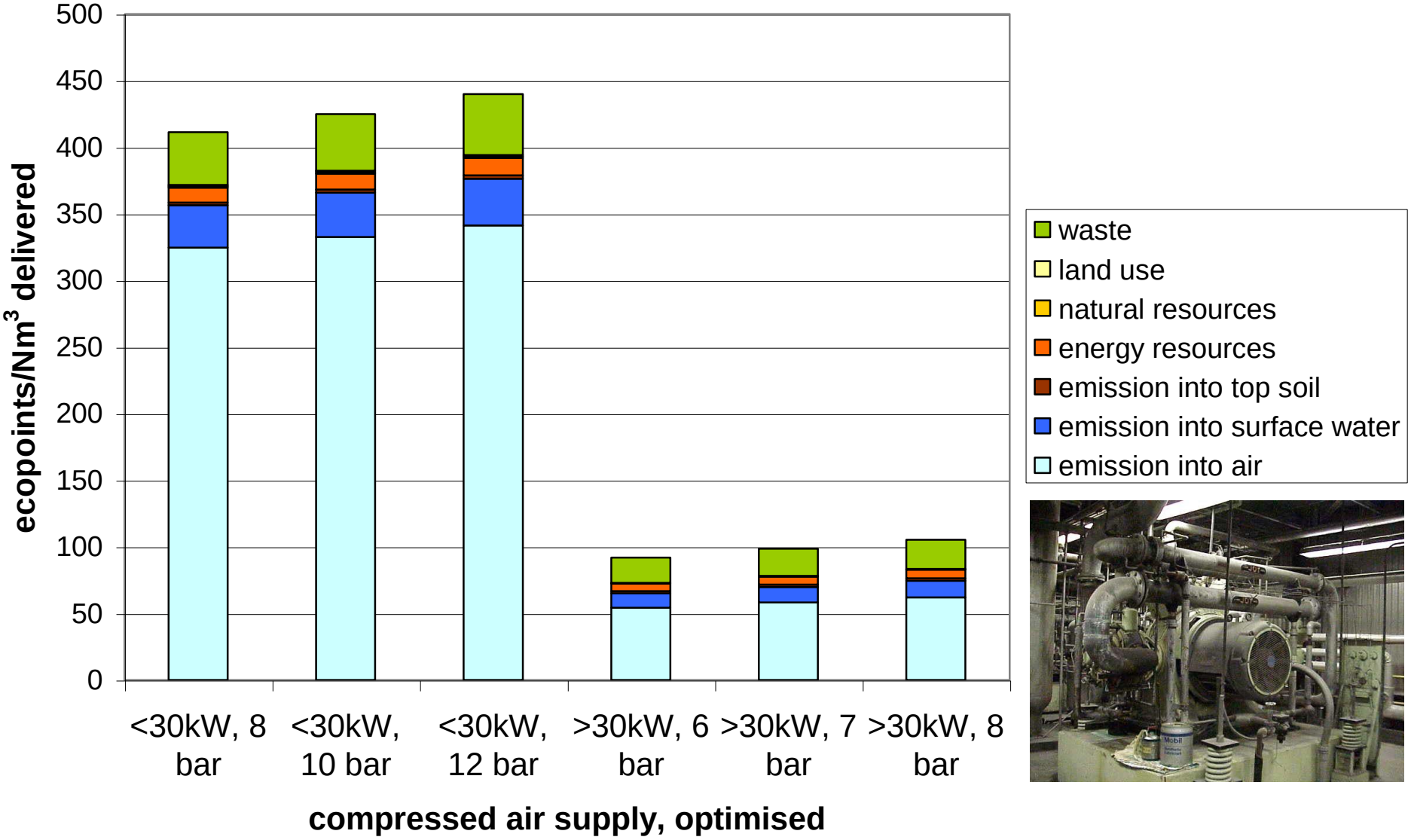
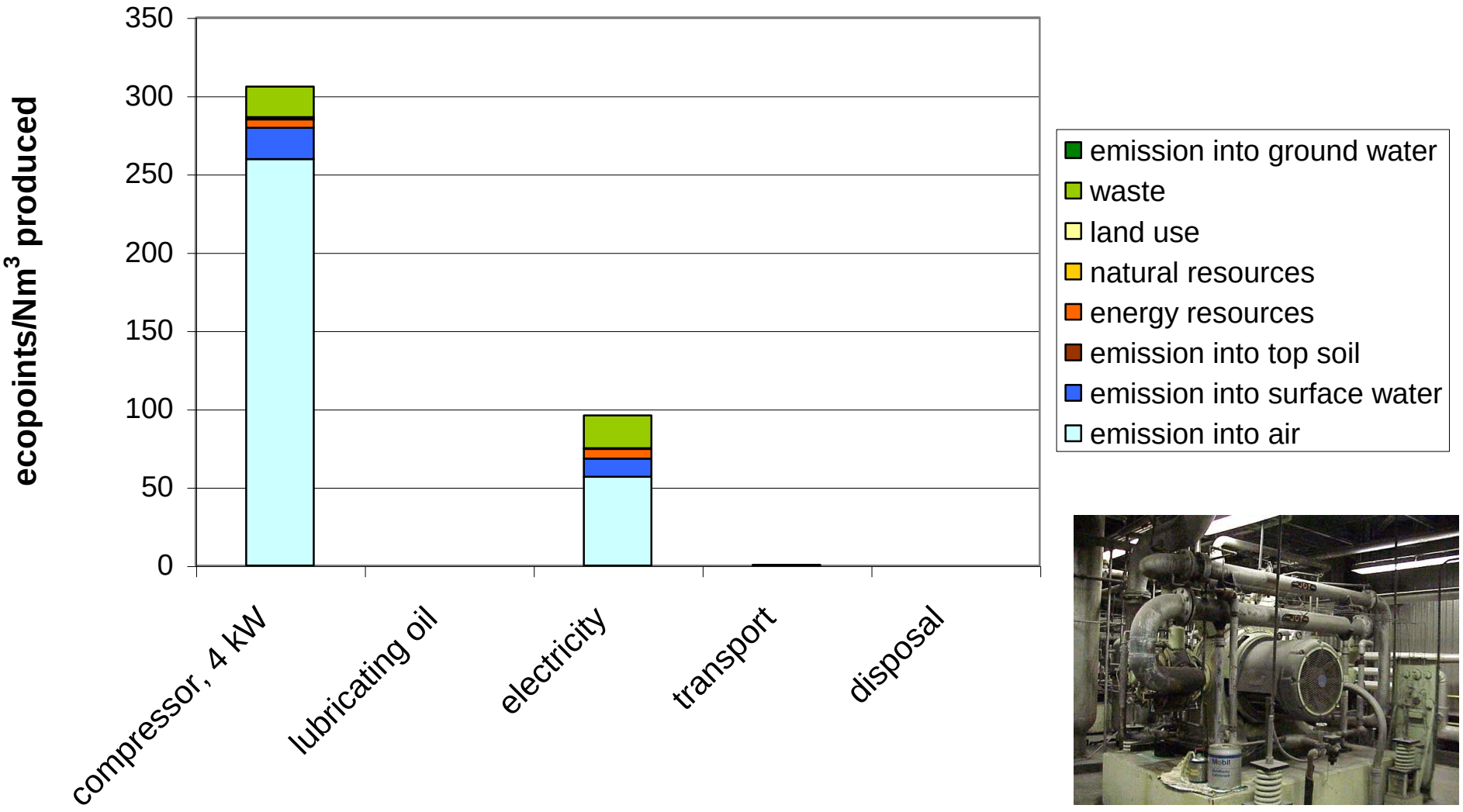
Results: cumulative energy demand



Results: ecological scarcity 06

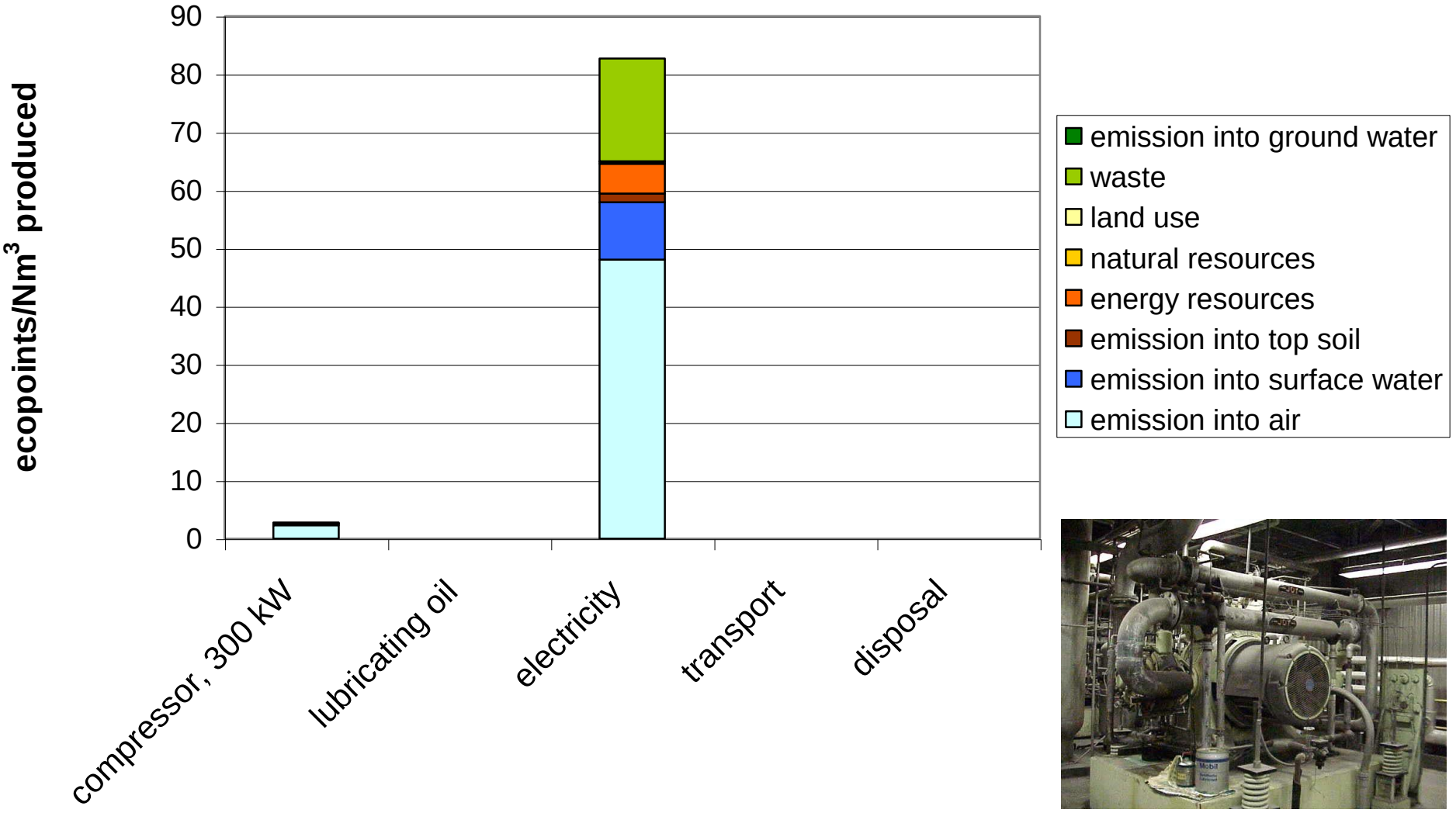


Contributions: ecological scarcity 06



compressed air supply, small, 10 bar

Contributions: ecological scarcity 06



compressed air supply, big, 7 bar

Conclusions

- chipping processes: production of material removed is dominant
- chipless shaping: deformation energy and general factory operation are most important
- laser machining dependent on power needed
- compressed air: substantial difference particularly between average, optimised and best
- metal machining datasets do not include degreasing
  => add it separately

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