the clean car – dirty metals connection

ideas for action

Reinier de Man
clean car

- in NL and D: catalytic converters are obligatory in new cars from 1993
- catalytic converter transforms NO, CO and C\textsubscript{x}H\textsubscript{y} into N\textsubscript{2}, CO\textsubscript{2} and H\textsubscript{2}O
- despite traffic increase, air quality in towns has improved
NO$_x$-emission strongly reduced with traffic increase

without catalytic converter emission would have been 5 times higher now (example NL)
catalytic converters work with PGM

- PGM = platinum group metals: Platinum, Palladium and Rhodium
- PGM = active catalytic component, e.g.
  - Pt/Rh 5:1 or
  - Pd/Rh 5:1
- some 40% of PGM used for catalytic converters
South Africa and Russia are dominating the PGM market

<table>
<thead>
<tr>
<th></th>
<th>market share</th>
<th>mining method</th>
<th>areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>platinum</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>68%</td>
<td></td>
<td>Bushveld</td>
</tr>
<tr>
<td>Russia</td>
<td>24%</td>
<td>By-product of nickel mining</td>
<td>Norilsk</td>
</tr>
<tr>
<td><strong>palladium</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>23%</td>
<td>primary</td>
<td>Bushveld</td>
</tr>
<tr>
<td>Russia</td>
<td>69%</td>
<td></td>
<td>Norilsk</td>
</tr>
<tr>
<td><strong>Rhodium</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>75%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PGM and Nickel in Russia

General
Russia’s nickel/PGM industry

- RAO Norilsk Nickel: 219,000 t nickel, 373,000 t copper
  - Norilsk Mining and Metallurgic Combinat (Siberia, Northern Krasnoyark)
  - Kola peninsula
    - Severonickel Monchegorsk
      - mine reserves exhausted
      - ores from Norilsk Siberia
    - Penchenganickel (Zapolyarny, Nikel)
      - no PGM here
- three other, less important companies
PGM and Nickel in Russia

Norilsk,
Siberia
The Norilsk Combinat is accessible only by air or Arctic shipping. This integrated complex operates seven mines, two concentrators, and smelters and refiner-ies. It produces nickel and copper cathodes, copper anodes, refined cobalt, and platinum group/precious metal concentrates. As well, the Norilsk Combinat sends nickel and copper in ore and matte to RAO Norilsk’s two subsidiary operations in the Kola Peninsula for further processing. Materials are transported by Arctic shipping via the port of Dudinka on the Yenisei River. About 100 000 work-ers were employed at the Norilsk Combinat at the beginning of 1998. In September, management and the unions agreed to reduce employment levels to 90 000 by year-end through voluntary departures and a hiring embargo. At the end of 1996 the Norilsk Combinat employed an estimated 140 000 workers.
Norilsk history

- **Gulag**
  - construction started in 1935
  - Gulag became responsible for Norilsk combine
  - between 1935 and 1955, 500,000 prisoners came to Norilsk, most of them died there.
  - after the Gulag system collapsed, for many there was nowhere to go

- **break-down of Soviet Union**
  - Norilsk was privatised
  - owner = Vladimir Potanin, one of Russia’s richest business men
Norilsk (Siberia): ecological disaster
Norilsk: human disaster
Norilsk City

- City of 230,000 inhabitants, 200 miles above the arctic circle
  - extremely polluted city
  - winter temperatures go down to -40°C
  - completely isolated, only air connections or via Dudinka harbour
    - 122 km railway Norilsk - Dudinka
  - leading in Aids and narcotics
  - closed for foreigners
Norilsk: emissions

- $\text{SO}_2$ - emissions
  - 1992: 2.3 mio t = 20 times Sweden,
  - 2001: 3 mio t

- metal dust emissions

- other toxic emissions
Siberia emissions (IIASA 1998)

Norilsk SO$_2$
Norilsk: ecological damage

- **forest destruction**
  - 4000 km$^2$ of larch forest died (until 1992)
  - IIASA 1998:
    - “It is generally accepted that the Norilsk industrial complex is a main contributor to forest die back and earlier stages of forest decline for at least 7,520 km$^2$, potentially more when considering transport capabilities of the many heavy metals emitted from its heavy industries.”

- **loss of land and lakes**
  - loss and contamination of reindeer land
    - “20 million hectares of the best reindeer pastureland has been lost “ (N. Izvestija 2001)
    - reindeer meat is heavily contaminated → serious health problems of indiginous people
  - “20,000 hectares of lake area in the Norilsk-Pyasino system are completely ruined” (N. Izvestija 2001)
Norilsk company: from AR 2001

1 | MISSION AND STRATEGY OF MMC NORILSK NICKEL

MISSION

- What is the key objective of MMC Norilsk Nickel?

To increase shareholder value
Norilsk company: revenue

- Nickel 27%
- Copper 19%
- Palladium 33%
- Platinum 14%
Norilsk company: ecology

“MMC Norilsk Nickel is fully aware of its responsibility to protect the natural environment of the areas where its industrial operations are located. At the end of 2001, significant progress was achieved in negotiations with the Norwegian Government and Scandinavian banks regarding the launch of an ecological program in the Kola Peninsula. The Group is also finalizing a long-term ecological development program for the Taimyr Peninsula. We are confident that the implementation of these programs will allow us to further minimize the harmful effects to the environment MMC Norilsk Nickel may generate”

Norilsk PGM customers

- customers (according to Taiga Rescue Network 1997/Platinum 2002)
  - Mitsubishi (via Norimet)
  - General Motors (via Norimet)
  - Toyota
  - Nissan
  - Ford, Daimler, Chrysler?

- trade
  - through daughter Norimet, London
Norilsk: emission reduction

- Arctic Council Action Plan 2001
  - 4 year programme
  - reduction 30-40%
  - implementation?
PGM and Nickel in Russia

the Kola Peninsula
RAO Norilsk’s Severonickel subsidiary in Monchegorsk exhausted its mine reserves in 1977. Severonikel processes nickel-copper ore and nickel matte from the Norilsk Combinat. The subsidiary’s facilities include an Outokumpu flash smelter, converting facilities, and copper and nickel refineries. In June, a corporate tax collection commission ordered Severonikel to pay 250 million roubles in back taxes and 400 million roubles in fines. Severonikel disputed the claim, asserting that the government owed it about 250 million roubles in value-added tax refunds on exports. Severonikel is the major employer for the Murmansk region and provides the region with most of the taxes paid. The back taxes and fines were beyond Severonikel’s capacity to pay immediately; a compromise was reached whereby Severonikel could pay the back taxes over time. There were indications that throughput of primary matte at Severonikel could be reduced while, at the same time, the company might offset this by increasing the processing of nickel and cobalt-bearing scrap. In the spring of 1998, Severonikel obtained a tolling contract for nickel- and cobalt-bearing scrap, sludges and turnings from the United States and Europe.
A recent tax scandal ...

- **Russian decree of 1.1.1999**: extra tax for harmful pollution
- **2002**: Russian high court decision
  - decree not valid
  - Norilsk – Nikel must not pay tax

“I praksis betyr dette at smelteverkene i Nikel og Montsjegorsk fortsatt kan slippe ut miljøskadelige stoffer til luft og vann uten ekstra kostnader. I tillegg får de altså tilbakebetalt miljøskatten som allerede er betalt inn. Kola Gruve- og Metallurgi selskap betalte inn avgiften i to år, før de i 2001 nektet videre innbetalinger. “ (Bellona website)
Pechenganikel

The Pechenganikel subsidiary of RAO Norilsk operates four underground and open-pit mines at Zapolyarny and Nikel in the northernmost part of the Kola peninsula. Unlike those at the Norilsk Combinat, the Pechenganikel deposits do not contain platinum group metals. A concentrator handles the output from the Pechenganikel mines as well as shipments of higher-grade ore from the Norilsk Combinat. Pechenganikel’s smelter at Nikel processes the concentrates to produce a copper-nickel matte that is sent to Severonikel for further processing.
The Kola desert (1)
If the desert formation is not stopped, it will take 500-600 years to restore the landscape, says Russian scientist.
Kola – some emission data

**Severonikel**
- largest copper-nickel smelter in the world
- air emissions:
  - 1992: 180,000 t SO₂
  - 3000 t copper
  - 2700 t nickel

**Pechenganikel**
- Nikel & Zapolyarnij
- Nickel from Norilsk ores:
  - up to 30% sulphur
- SO₂ emissions
  - 1979: 400,000 t SO₂
  - 1992: 275,000 t SO₂
  - at present: 150,000 (?) t SO₂
Energy and Transport

- Energy use
  - huge energy use at Monchegorsk + Pechenga
  - about 8 TWh (according to N og U)

- Transport:
  - Transport road
    - ore production at Norilsk
    - transport to Dudinka, Yenisey river
    - over sea to Kola (= distance Gibraltar – Oslo)

- Energy use and risks
  - sea open with ice-breakers, high energy costs
  - only 3 months with diesel-ships, 9 months with nuclear powered ships.
Kola – environmental damage

- Forest damage
  - forest death area near Monchegork 40,000 – 50,000 ha, according to 1995 study
  - major emissions in Finnish Lapland, e.g. Inari region.
heavy metal air pollution

Major point sources in the former Soviet Union of heavy metals to the air.
Kola – international co-operation, studies

- **Norsk-Russisk Miljøvernkommisjon**
  - established 1988
- **Pechenganikel modernisation**
  - Norway Dep. of Environment, Nordic Investment Bank, Kola Mining and Metall. Cie (part of Norilsk): agreement in 2001 to modernise Pechenga plant (Nikel & Zapolyarnij). 93,5 USD (with support from Norway and Sweden)
  - 90% emission reduction by 2006.
  - "After the implementation of the project, Pechenganikel will become one of cleanest metallurgical plants in the world," [Norilsk First Deputy CEO Dmitry Zelenin]
PGM in South Africa

Rustenburg,
South Africa
PGM in South Africa

*slides on South Africa not yet included*
The clean car – dirty metals connection

PGM production and markets a closer look
Platinum supply & demand

Platinum supply

Platinum demand

- Others
- North America
- Russia
- South Africa

- Other
- Autocatalyst (net)
palladium supply & demand

**Palladium Supply**
- 1993: Others, North America, Russia, South Africa
- 1994: Others, North America, Russia, South Africa
- 1995: Others, North America, Russia, South Africa
- 1996: Others, North America, Russia, South Africa
- 1997: Others, North America, Russia, South Africa
- 1998: Others, North America, Russia, South Africa
- 1999: Others, North America, Russia, South Africa
- 2000: Others, North America, Russia, South Africa
- 2001: Others, North America, Russia, South Africa
- 2002: Others, North America, Russia, South Africa

**Palladium Demand**
- 1993: Other, Autocatalyst (net)
- 1994: Other, Autocatalyst (net)
- 1995: Other, Autocatalyst (net)
- 1996: Other, Autocatalyst (net)
- 1997: Other, Autocatalyst (net)
- 1998: Other, Autocatalyst (net)
- 1999: Other, Autocatalyst (net)
- 2000: Other, Autocatalyst (net)
- 2001: Other, Autocatalyst (net)
- 2002: Other, Autocatalyst (net)
### Ton/Das long term scenarios: assumptions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>amount of Pt in fuel cell</th>
<th>dev. country light duty vehicle demand</th>
<th>market penetr. of fuel cell veh.</th>
<th>other PGM demands</th>
</tr>
</thead>
<tbody>
<tr>
<td>best case PGM supply/demand</td>
<td>low</td>
<td>low</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>Limited Progress on Platinum Fuel Cell Target / Low Demand Levels</td>
<td>high</td>
<td>medium</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Platinum Fuel Cell Target Met/ Average Demand Levels</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
</tr>
<tr>
<td>Best Case for Developing Countries</td>
<td>medium</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Worst Case PGM Supply/Demand</td>
<td>high</td>
<td>high</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>

Bruce E. Ton, Sujit Das, An Assessment of Platinum Availability for Advanced Fuel Cell Vehicles, Oak Ridge National Laboratory, November 9, 2001
Ton/Das long term scenarios: results

PGM demand scenarios

year
2000 2010 2020 2030 2040

1000 kg

best case PGM supply/demand
Limited Progress on Platinum Fuel Cell Target / Low Demand Levels
Platinum Fuel Cell Target Met/ Average Demand Levels
Best Case for Developing Countries
Worst Case PGM Supply/Demand
Material intensity: Schmidt-Bleek

- PGM material intensity about 300,000: for 1 gram PGM 300 kg of ore.
- “Building a catalytic converter for an automobile with virgin platinum requires close to three tons of non-renewable nature. Assuming that this equipment functions for 100,000 km, some 30 grams of nature are consumed for every km driven, or 3 kg per 100 km. This consumption is not so different in weight from the fuel consumption of the vehicle. And the catalyst has been legally prescribed to protect the environment. That's what I call a mono-linear non-systemic solution.”
The clean car – dirty metals connection

heavy metal pollution during use
PGE in the environment

- PGE concentrations are low
- direct human health risks is to believed low
- there are concerns about potential environmental effects, however
- this issue may come up in the years to come

“While catalytic converters have been dramatically successful in reducing automobile emissions and preserving the atmosphere, their use has led to the widespread release of potentially hazardous metals. “

WHOI, 2000
The clean car – dirty metals connection

Ideas for action
the clean car - dirty metal connection
Partnerships [1]: for what?

- create sustainable supply base for metals
- create sustainable business for all partners in the supply chain
  - economically attractive
  - socially attractive
  - environmentally attractive
- protect & restore unique eco-systems, biodiversity
  - forests
  - freshwater, sea
Partnerships [2]: who?

- private actors
  - automobile industry
  - catalytic converter producers, recyclers
  - PGM producers
  - financial institutions
- NGOs
  - environmental NGOs
    - Russia
    - international
  - social NGOs
- Government institutions
  - Nordic countries
  - Western Europe
  - Russia
Role of automobile companies and/or catalytic converter producers

- Creating transparency
  - on PGM sources
  - and their environmental/social ‘history’

- Helping
  - PGM producers create transparency
  - PGM producers improve their processes
  - PGM producers communicate with end-consumers, NGOs

- Requiring data
  - data on environmental damage
  - data on social performance

- Requiring action
  - on environmental improvement
  - on social standards
Role of financial actors

- Investors in PGM industry
  - ask for full transparency
  - require change towards sustainability

- Investors in automobile industry
  - ask for transparency on supply chain,
  - especially for PGM
  - reward positive contribution towards solving problems in supply chain
Role of NGOs

- use the link between the ‘clean car’ and PGM’s ecological footprint
- use the emotional value of the forest
- link with social issues
Partnerships [3]: what?

- creating transparency in the car – metal chain
  - change incentive through transparency
  - include PGM and other metals
- eco-efficiency and good management
  - e.g. automobile industry helps PGM producer with management issues
- financial issues
  - financial aid from user countries for improvement of metal production
  - upstream investment / participation
- etc. etc.
Creating transparency

- Showing the realities of PGM production in Russia
  - technical realities
  - social and economic realities
  - environmental realities

- Company transparency of PGM producers
  - company reporting
  - environmental and social reporting
Partnerships [4]: how?

- supply chain co-operation projects
- NGO-industry platforms
- scientific co-operation projects
- co-operation between countries
- international/multidisciplinary symposia