This is Finnfjord AS

- Annual production 100,000 mt ferrosilicon
- Annual production 20,000 mt microsilica
- 120 employees
- 800 mill NOK turnover (08)
- 3 furnaces: Total capacity 110 MW
- Local ownership - private stock holding company.
- ISO 9001 and 14001 certified
- One of the 10 largest single FeSi plants
- Supplies EU with 10-15% of FeSi
The Norwegian Ferroalloy industry
OUR PRODUCTS

What is Ferrosilicon?

- Alloy of iron and silicon
- Necessary in the production of steel and iron based foundry alloys
- Makes steel hard & tensile

What is Microsilica?

- Amorphous fumed silica, > 90% SiO₂
- Ingredient in concrete, fibre reinforced concrete, refractory material etc.
Main marked- The Iron & Steel industri

- Need 3–20 kg ferrosilicon to produce 1000 kg steel
- Ferrosilicon represents about 0.8% of total cost for production of steel
How to manage the climate change challenge?
Finnfjords contribution

Recover energy from flue gases and to become the first CO$_2$ neutral Ferrosilicon producer
The ferrosilicon process - energy flows

- Energy in raw materials
- Electrical Energy
- Energy in off gases
- Energy in cooling water
- Energy in thermal radiation
- Energy in tapped metal & slag (Chemical energy, temperature & latent heat)

Furnace process
Condensation
Heating
Chemical reactions
Sankey- diagram of energy flows in the ferrosilicon process
Production of Ferrosilicon is energy intensive

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical energy</td>
<td>950 GWh</td>
</tr>
<tr>
<td>From combustion of coal &amp; coke</td>
<td>1050 GWh</td>
</tr>
</tbody>
</table>

Total 2 TWh energy

- Energy for supply a city 90,000 of inhabitants
- 3.5 Alta Power Plants
Energy & exergy in recovery processes
## Technologies & Costs

<table>
<thead>
<tr>
<th>Technology</th>
<th>Waste heat medium</th>
<th>Heat recovered as</th>
<th>Temp range of waste heat</th>
<th>Yield</th>
<th>Euro/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat exchangers</td>
<td>Waste gas/cooling water/hot oil</td>
<td>Hot water</td>
<td>50-200 °C</td>
<td>75-95 %</td>
<td>0,4-2</td>
</tr>
<tr>
<td>Heat pump</td>
<td>Water /exhaust air</td>
<td>Hot water (temp 50-90 °C)</td>
<td>25-60 °C</td>
<td>COP: 3-5</td>
<td>30-50</td>
</tr>
<tr>
<td>Shell boiler, water based</td>
<td>Waste gas</td>
<td>Saturated steam 6-15 bar Temp: 160-200 °C</td>
<td>200-600 °C</td>
<td>30-65 %</td>
<td>25-50</td>
</tr>
<tr>
<td>Water tube boiler, water based</td>
<td>Waste gas</td>
<td>Super heated steam 8-60 bar Temp 280-480 °C</td>
<td>400-1000 °C</td>
<td>30-75 %</td>
<td>40-150</td>
</tr>
<tr>
<td>Boiler ORC/turbine</td>
<td>Waste gas</td>
<td>Electricity</td>
<td>150-500 °C</td>
<td>10-15 %</td>
<td>70-120</td>
</tr>
<tr>
<td>Boiler water/turbine</td>
<td>Waste gas</td>
<td>Electricity</td>
<td>500-1000 °C</td>
<td>20-35 %</td>
<td><strong>300-400</strong></td>
</tr>
<tr>
<td>Thermoelectric panel</td>
<td></td>
<td>Electricity</td>
<td>Heat radiation 800-1500 °C</td>
<td>5-10 %</td>
<td></td>
</tr>
</tbody>
</table>
Finnfjords three stage plan for ER & 0 -emission!

2009/2012

Energy recovery

Recovery og approx 30 % of electrical input

2012/2015

Bioenergy

Use of excess heat for production of biopellets

2020

Thermal Power Plant With CCS

CCS capture from Finnfjord
Step 1 - Energy recovery

- Reducing energy consumption in the process with 40%!!
- Recovering 340 GWh of electric energy
Timeline electricity recovery project

- 2008: Initial studies
- 2009: Organizing & financing
- 2010: Engineering and contracting
- 2011: Construction
- 2012: Construction & commissioning

Development/optimization

260 GWh el → 340 GWh el!
### Energy utilisation (GWh)

<table>
<thead>
<tr>
<th>Category</th>
<th>Electricity</th>
<th>Bioenergy</th>
<th>Thermal power plant</th>
<th>Off gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses</td>
<td>1 000</td>
<td>730</td>
<td>550</td>
<td>130</td>
</tr>
<tr>
<td>Energy in product</td>
<td>620</td>
<td>620</td>
<td>620</td>
<td>620</td>
</tr>
<tr>
<td>Electricity rec.</td>
<td>270</td>
<td>450</td>
<td>870</td>
<td></td>
</tr>
<tr>
<td>Auxiliary equip.</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Cooling water</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>Total</td>
<td>2 000</td>
<td>2 000</td>
<td>2 000</td>
<td>2 000</td>
</tr>
<tr>
<td>Yield</td>
<td>32 %</td>
<td>45 %</td>
<td>55 %</td>
<td>75 %</td>
</tr>
</tbody>
</table>
Regional development

Investments and spin-offs

- 90 million Euros in step: 1 Electric energy recovery facility.
- In addition 10 million Euros in a new workshop and service building
- Founded Finnfjord Miljøenergi AS together with Troms Kraft AS-with the aim of producing 100 000 mt wooden pellet for industrial downstream use
- Founded Finnsnes Industrial Park based on energy supply from Finnfjord AS a regional port and a public industrial green field area.
Last but not least

Energy recovery from process industry is the most environmental friendly contribution to increase the available energy amount!
Thanks for your attention!