# Measures for the reduction of fuel consumption and CO₂ emissions in inland navigation

## 1. Keywords
ReFRESCO, PROCAL, hull optimisation, drag, shallow water, computational fluid dynamics (CFD), prototype measurements, drag reduction, benchmark, retrofit, propeller hull interaction, fuel savings, energy efficient

## 2. Short description
The MARIN’s CFD code ReFRESCO can be used to calculate the flow around the vessel of detailed hull forms. In addition, ReFRESCO can be linked to the propeller analysis programme PROCAL. This allows for analysis of vessel and vessel-propeller interaction. We are going to apply these programmes to improve the fuel consumption of existing inland shipping vessels.

We start with on-board measurements of existing vessels to record their performance. Next, to analyse the performance of the vessels, ReFRESCO calculations of all measured vessels are carried out. Based on these calculations, improvements to the hull are recommended and the pay-back time is calculated.

## 3. Objective & target
For each vessel, a report is prepared containing recommendations for improving the vessel and the pay-back time of these improvements. The skipper or shipping company can use this report to make a well-considered choice to invest in making his vessel energy efficient and therefore reduce CO₂ emissions.

## 4. Key success factors
The MARIN is highly experienced in optimising vessels with CFD, but primarily for marine navigation and less so for inland shipping. Optimisation with CFD has turned out to be a success in marine navigation, and will also be the case for inland shipping.

## 5. Innovative aspects
The CFD code ReFRESCO developed by MARIN and the link with PROCAL will be applied to optimise inland shipping vessels for the first time.

## 6. Benefits for users
This method is used to investigate how a vessel can be improved as well as what the pay-back time is. This is practical information, which a skipper or shipping company can use to decide whether or not to invest.

## 7. Geographic area
When optimising a vessel it is very important for the design condition to be properly determined. Thus, it is important to determine the average water depth of the route the vessel is going to sail. The geographic area is not limited: it applies to all inland shipping vessels in all situations.

## 8. Status
MARIN’s code ReFRESCO is already being used in marine navigation and offshore shipping. This year we would like to use ReFRESCO on a large scale for inland shipping.

## 9. Difficulties met
A ReFRESCO calculation is time-consuming.

## 10. Year(s)
the next 3 years

## 11. Users, stakeholders
Skipper owners, inland shipping companies

## 12. Contact person
Karola van der Meij or Henk Blaauw
<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Reduction of CO2 emissions through optimisation of the hull by using CFD.</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Costs &amp; financing</td>
<td>Research funds from the MARIN, JIP SAVE (Group of 15 Dutch inland shipping companies, and FP7 MoVeIT!</td>
</tr>
<tr>
<td>14</td>
<td>Website / links</td>
<td><a href="http://www.marin.nl/web/Ships-Structures/Inland-ship-1.htm">http://www.marin.nl/web/Ships-Structures/Inland-ship-1.htm</a></td>
</tr>
<tr>
<td>16</td>
<td>Added value: possibility for application elsewhere</td>
<td>In the coming years, this method will be used for existing vessels from the Netherlands and Europe. ReFRESCO can also be used for new inland shipping vessels to be built.</td>
</tr>
<tr>
<td>17</td>
<td>Further information</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Filled in by</td>
<td>Karola van der Meij</td>
</tr>
<tr>
<td>19</td>
<td>Date</td>
<td>29-03-2011</td>
</tr>
</tbody>
</table>