### BUY

<table>
<thead>
<tr>
<th>Bloomberg</th>
<th>MOIL LN</th>
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<tbody>
<tr>
<td>Price (p)</td>
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<tr>
<td>Target Price (p)</td>
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<td>Upside (%)</td>
<td>365%</td>
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<td>12mth high/low (p)</td>
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<td>Shares out (mill)</td>
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<td>Fully diluted (mill)</td>
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<tr>
<td>Mkt Cap (US$m)</td>
<td>84.4</td>
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<tr>
<td>Enterprise Value (US$m)</td>
<td>28.4</td>
</tr>
</tbody>
</table>

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Investment case

The presence of heavy oil in Madagascar has been known for more than a hundred years, but low oil prices, remote location and lack of infrastructure has left the huge onshore deposits effectively stranded. However advances in technology and a more robust oil price outlook means that is all about to change, with Madagascar Oil one of the principal beneficiaries.

Madagascar Oil is the largest onshore acreage holder in Madagascar, with five contiguous licences covering an area of 29,500 km². Two of the licences contain major, heavy oil accumulations with multi-billion barrel potential, with Tsimiroro being the jewel in the crown. Madagascar Oil has invested more in the country than any other oil company to date, and was the first to produce oil. Following the resolution of its licence problems, Madagascar Oil can now focus on becoming the first company to deliver sustainable production from its world class Tsimiroro asset.

Tsimiroro – Pilot holds the key

The Tsimiroro field in Block 3104 is Madagascar Oil’s star asset, containing 1,688 million barrels (mmbbls) of in-place contingent resources, according to Netherland Sewell & Associates (NSAI). Although the field has been known about for more than 100 years, its true scale was hidden. Prior to 2008 it was only thought to contain around 300 mmbbls of oil, which combined with the heavy nature of the crude (13° API) and its relative geographic isolation, meant the field was not commercially viable. However an extensive drilling campaign to prove up additional resource, combined with a successful cyclic steam stimulation (CSS) pilot to demonstrate the productive potential of the reservoir and the mobility of the crude once heated, has transformed the outlook for the asset.

While the success of the CSS or “huff-and-puff” is encouraging, it will only deliver an ultimate recovery of around 16% which is hardly going to blow the house down. However the field appears ideally suited to a conventional steam flood approach, whereby discrete steam injectors raise the temperature of the entire reservoir interval, enabling recoveries in excess of 60%. To test whether this approach will work at Tsimiroro, the company plans to drill a nine-pattern (25 well) pilot next year, with steam injection commencing in the second half of 2012. If the pilot proves successful, the value of the asset to a resource-hungry acquirer will be significantly enhanced. Based on current contingent resource estimates, the field has the potential to be one of the top steam flood projects in the World with production peaking at more than 150,000 barrels of oil per day. In parallel with the pilot, Madagascar Oil will continue to drill delineation wells to increase the size of the contingent resource base. The latest NSAI report increased best estimate contingent resources by 75% following last year’s successful drilling campaign, and with a best estimate in place prospective resource of 2,189 mmbbls, there is certainly scope for further upgrades.

Exploration upside

The decision to abandon plans for a bitumen mining project at Bemolanga, although disappointing, came as no real shock. Independent consultants Norwest calculated a break-even oil price for the project of US$110.85, assuming a 12% discount rate. Operator Total nevertheless spent considerable time and money on the licence, and has been sufficiently encouraged not to give up completely. The Malagasy Government has granted the JV partners an extension to the current PSC exploration phase in order to pursue potential light oil plays deeper in the stratigraphic sequence.
As well as the Tsimiroro and Bemolanga acreage, Madagascar Oil has wholly owned interests in three large blocks immediately to the south of Tsimiroro. Blocks 3105, 3106, and 3107 cover 17,400 km² of early stage exploration acreage, on trend with the Tsimiroro and Bemolanga giant oil fields. Recent micro-seepage studies have given some encouragement and Madagascar Oil plans to follow-up with a 16,000 km FTG gravimetric survey once the work programme has been approved by the government.

The elephant in the room

Madagascar Oil has not had the easiest start to life as a public company. The majority of the nine months since floating have been spent in a legal tug-of-war with the Malagasy Government over the validity of the company’s assets.

Crucially though, this dispute has now been resolved, with the industry regulator OMNIS, and the Ministry of Mines and Hydrocarbons acknowledging that the Tsimiroro PSC is valid, and approving the 2011-2012 work programme and budget. Furthermore, the Ministry has acknowledged that Madagascar Oil has suffered a six-month force majeure event, and there is the option to further extend the licence term if required at the end of the current period.

Understandably, Madagascar Oil’s share price is being heavily discounted due to uncertainties surrounding the political situation in the country. However, while it is correct that caution should be taken when investing in such politically volatile regions, we believe that Madagascar Oil is now in a politically stronger position than it was at the time of the IPO. The dispute has been resolved, and Madagascar Oil has negotiated extensions to contracts to ensure that it is not disadvantaged by the time lost during the suspension of operations.

Over the past nine months Madagascar Oil has had numerous meetings with the government, and any question of non-compliance with the terms of its Tsimiroro licence have been well and truly put to bed. The government now has a much clearer idea the level of investment and technical work that has already been put into the project, and the clear road map to take the field through to commercial development. With democratic elections and the removal of international sanctions scheduled for 2012 we firmly believe that the worst is now behind us.

Valuation: Core NAV US$480m or 146p/share

We have calculated a value for Madagascar’s Tsimiroro asset using standard discounted cash flow methodology, with a 12% discount rate and a US$85/bbl long-term Brent price. In light of the events over the past nine months, we have increased our risk factor on the project to 50%, which includes the 80% chance of success ascribed by NSAI. After adjusting for corporate items, we arrive at a core NAV for Madagascar Oil of US$480m (US$895m unrisked) or 146p/share (273p/share unrisked). This excludes any value for the 2 billion barrels plus of prospective resources at Tsimiroro, or any value for Bemolanga or the three exploration licences.

The valuation is very sensitive to both the oil price and the discount rate, and it is probable that a potential acquirer would have a significantly lower cost of capital and in all likelihood, a more bullish view of long term oil prices than we are currently assuming. Cutting the discount rate to 10% and using a US$100/bbl flat nominal oil price lifts the unrisked value for Tsimiroro alone to more than US$2.3 billion.
Corporate overview

Madagascar Oil is a Bermudan company, with operational offices in Antananarivo, Madagascar, and management offices in Houston, USA. The company focuses solely on Madagascar, and has the largest onshore acreage position in the country.

A brief history of the company

Madagascar Oil was incorporated in January 2006, following a re-organisation of an existing Mauritius company which had been founded in 2004 by a Canadian and British-based investor group. The newly formed company took on the existing assets, and set about structuring a plan of action for the company. Initial progress was slow, however in 2008-09 a new leadership team shook up the company’s management and operations, cutting costs and putting Madagascar Oil on a surer footing to extract value from its promising asset base. The company successfully listed on AIM in November 2010, raising US$80m to pursue a pilot project on the core Tsimiroro field.

Figure 1: Key corporate milestones

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Madagascar Oil founded. Acquires wholly-owned rights to operate 6 blocks, including Bemolanga and Tsimiroro fields.</td>
</tr>
<tr>
<td>Jan 2006</td>
<td>Company restructuring, new management. US$20m raised in equity for early stage exploration.</td>
</tr>
<tr>
<td>Oct 2006</td>
<td>A further US$30m raised from Touradji and Persistency.</td>
</tr>
<tr>
<td>Mar 2007</td>
<td>Madagascar Oil secures US$85m senior credit facility with Credit Suisse and a syndicate of lenders.</td>
</tr>
<tr>
<td>Sep 2008</td>
<td>60% of Bemolanga farmed out to Total for US$100m in cash and US$100m gross work programme.</td>
</tr>
<tr>
<td>Nov 2008</td>
<td>Company raises US$7m via equity issue.</td>
</tr>
<tr>
<td>Q4 2008</td>
<td>Debt facility repaid at an aggregate cost of US$97m using proceeds from farm-down of Bemolanga to Total.</td>
</tr>
<tr>
<td>Q1 2009</td>
<td>Change of management and reduction in headcount to minimise G&amp;A costs.</td>
</tr>
<tr>
<td>Q2 2009</td>
<td>Madagascar Oil relinquishes block 2103.</td>
</tr>
<tr>
<td>Jul 2009</td>
<td>US$5.5m raised through issue of shares to Grafton Resource Investments.</td>
</tr>
<tr>
<td>Jul 2010</td>
<td>Convertible notes issued to three largest shareholder groups, raising US$3m.</td>
</tr>
<tr>
<td>Aug 2010</td>
<td>Madagascar Oil secures US$10m equity investment from UK-based Blakeney Management.</td>
</tr>
<tr>
<td>Nov 2010</td>
<td>US$80 (gross) raised during IPO on AIM.</td>
</tr>
<tr>
<td>Dec 2010</td>
<td>Government advise MOIL that it is interested in buying all assets other than Bemolanga, with no guarantee of a fair price.</td>
</tr>
<tr>
<td>March 2011</td>
<td>Madagascar Oil declares force majeure on the four contested licences.</td>
</tr>
<tr>
<td>June 2011</td>
<td>During arbitration proceedings, Malagasy government accept the validity of the Tsimiroro PSC and the dispute is resolved.</td>
</tr>
<tr>
<td>June 2011</td>
<td>Total &amp; MOIL granted a one-year extension to Bemolanga PSC. Focus shifts from oil-sand mining to conventional exploration.</td>
</tr>
<tr>
<td>Sept 2011</td>
<td>NSAI update Tsimiroro resource estimates. Contingent resources increased by 75% to 1.7bn bbls OIP.</td>
</tr>
</tbody>
</table>

Source: Madagascar Oil.

Management

Madagascar Oil boasts an experienced and professional management team. Chairman and CEO Laurie Hunter founded Hunter Capital – a successful investment company involved in raising finance for early stage companies. COO Mark Weller, General Manager Avaro Kempowsky, and Chief Engineer Jim Lederhos all bring a wealth of experience in heavy oil projects; the three have almost a century’s combined experience working at Chevron on some of the world’s most successful steam-flood projects.
Madagascar – on the road to recovery

Overview

Madagascar is the world’s fourth-largest island. Lying off southeast Africa in the Indian Ocean, the former French colony has a population of nearly 20 million. Although blessed with extensive natural resources, Madagascar’s development over the last half-century has been hindered by flirtations with socialism, and a patchy political record. Now though, there is growing interest in developing the country’s mineral resources, and several major international companies are actively investing in the sector.

Politics

Post independence Madagascar has taken a winding path towards democratic rule. In the early 1990s long-serving, socialist-leaning President Didier Ratsiraka who originally came to power in a 1970s coup d’état, was defeated in multi-party elections. Ratsiraka returned to the presidency in 1997, but was defeated in a 2001 election by Marc Ravalomanana. Although popular in his tenure, Ravalomanana became mired in allegations of corruption, and, after international donors suspended aid in 2008, he was ousted amidst popular protest in March 2009.

The youthful new President, Andry Rajoelina, came to power after orchestrating protests against Ravalomanana. The international community regarded his presidency as unlawful, creating a political stalemate in Madagascar. In September 2011, under the guidance of the Southern African Development Community (SADC), Rajoelina signed an agreement with the other main political parties in Madagascar, agreeing a roadmap to presidential elections within a year. The agreement allowed for the return from exile of Ravalomanana and the recognition by the international community of Rajoelina as interim President.

Natural resources sector

Madagascar is best known for agricultural products, such as vanilla, but interest and investment in its natural resources sector has been growing in recent years. Despite the evident political issues facing the country, activity in the resources sector has continued under the influence of the state mineral resources agency OMNIS.

Major investors in the natural resources sector include Rio Tinto, whose ilmenite mine saw first production in 2009, and Sherritt International, which is investing over US$3bn in a nickel project. There is also a growing coal industry in the country; coal explorer Lemur Resources recently completed an IPO on the ASX. On the oil and gas side, Total has continued joint-venture operations at the Bemolanga field throughout the recent disruptions. Other companies with acreage in Madagascar include ExxonMobil and Tullow Oil, amongst many others.

All this activity is expected to contribute to renewed economic growth in Madagascar, following the negative impact of the global financial crisis, as well as political unrest in recent years. The IMF is currently forecasting a return to growth this year, with GDP growth of 0.6% forecast for 2011, rising to almost 5% next year.

For more information on Madagascar’s political situation and natural resources sector, see Appendix 2.
Tsimiroro

Overview

The wholly-owned Tsimiroro licence 3104 is Madagascar Oil’s most exciting asset. The block covers 6,670 km$^2$ in western central Madagascar and was acquired by Madagascar Oil following relinquishment by Hunt Oil. The Tsimiroro field lies within the licence and contains 1,688 mmbbls of best case, contingent resources (oil in place), with a further 2,189 mmbbls of best case, prospective resources across an additional 20 features.

The field contains heavy oil, typically 13° API, which will require conventional steam flood in order to flow at commercial rates. Independent consultant NSAI believes that a steam-flood development, similar to those at Kern River or Midway-Sunset in California, could produce at peak rates of over 150,000 bopd, which would comfortably place Tsimiroro in the top five largest steam-flood projects worldwide.

To move the project forwards, the company is commissioning a 25-well pilot project, to test the commerciality of the field under steam-flood recovery. Commissioning of the pilot project is underway, with the official ‘ground-breaking’ ceremony pencilled in for November. The plant is expected to be up and running by the end of next year.

Last year’s delineation drilling campaign recorded a 75% success rate, and on the back of the results, NSAI increased its contingent reserve estimate by 74%, and its prospective resource estimate by 179%. As further delineation wells are drilled we expect the resource estimates for the field to continue to rise.

Figure 2: Tsimiroro Field

Source: Madagascar Oil.
**Tsimiroro – the field geology**

The Tsimiroro field contains oil of typically 13° API predominantly in Triassic, Amboloando formation sandstones at depths ranging from 40-300 metres. The field comprises a series of structural traps, consisting of horst blocks, high-side three-way closures, and low-side closures with easterly dip. The Mokara shale provides an effective vertical seal, although trap integrity is a risk in areas where the shale has been deeply eroded, or where there is an especially high density of faulting.

The existence of reservoir, source rock, and the migration of oil into the structure are all proven. There are substantial Amboloando sandstones across the region, with numerous cores taken over the past century. The Permian lacustrine shales are mature, with sufficient organic content, and the oil has undoubtedly been able to migrate out of the shales (in some cases through to the surface to pool in seeps). Oil is accumulated in stacked fluvial channel sands and braided stream deposits of Late Triassic, Carnian age. The reservoir is of good quality with average porosities between 24% and 26%, and permeability in the region of 500 mD.

**Field history**

Up until Madagascar Oil’s acquisition of the field in 2004, 75 holes had been drilled by various parties; however, none pursued commercial development, principally due to the then prevailing low oil prices and the remote location. In 2007, Madagascar Oil commissioned a study by Weinman Geoscience in 2007, which established 32 new structures within the field, and a 2008 drilling campaign discovered significant volumes of oil with 14 out of 15 appraisal wells. However, it became clear that the high density oil at Tsimiroro required enhanced recovery techniques in order to establish commercial flow rates.

**Figure 3: Existing infrastructure at Tsimiroro**

![Existing infrastructure at Tsimiroro](image)

Source: Mirabaud Securities.

**Heavy oil**

The two methods that Madagascar Oil investigated were steam-flood and cyclic steam stimulation (CSS), which both involve heating of the reservoir using injected steam. The techniques (summarised in Figure 4, and looked at in more depth in Appendix 4) have been widely utilised, especially in the US and Indonesia, where they have a long and proven track record.
Figure 4: Steam injection techniques

Steam-flood
Stage 1: Steam injection
Steam is injected into the reservoir
Stage 2: Steam drive
Viscous oil heated by steam and drives oil towards producer well
Stage 3: Production
Heated oil and water are pumped to the surface

CSS
Stage 1: Steam injection
Steam is injected into reservoir
Stage 2: Soak phase
Steam and condensed water heat the viscous oil
Stage 3: Production
Heated oil and water are pumped to the surface

Source: Shell, Canadian Centre for Energy Information.

In order to prove the viability of the project, Madagascar Oil set about a two-stage pilot study, during which it planned to assess the field’s performance when subject to the two techniques.

Stage 1 pilot: 2008 CSS
A production testing facility was completed in 2008 in the TO-1 field area to assess the mobility of the heavy oil. Three Amboloando wells were subjected to cyclic steam stimulation (CSS) and placed on production. The wells peaked at between 100 and 150 bbls/d of oil, with a steam oil ratio (SOR) of approximately 3.4 barrels of steam for each barrel of oil generated (BS/BO), and a classic stimulated production decline was exhibited. Furthermore, the pilot confirmed several other factors, namely that the local water source was suitable for steam generation, the crude produced was of sufficient quality to be used to power the plant, and that the wells will produce with open hole completions without the need for special production liners.
The results were clearly encouraging, as they proved that steam was effective in mobilising the oil. The results also allowed the CSS well performance over a 1,000 day period to be modelled (Figure 6). As Figure 6 below shows, the production will peak in the second cycle, as the radius of the area affected by steam increases as proximal oil is produced.

CSS alone however, would be a very inefficient way to develop the field, delivering a recovery factor of around 16%. Steam-flood, by contrast, is likely to deliver recovery factors in excess of 60% (the NSAI best estimate assumes 70%).

**Stage 2 pilot: 2012 steam-flood**

The second stage of pilot production, planned for 2012, will test the commerciality of the field under steam-flood recovery. As the name suggests, steam flood relies on saturating the reservoir with hot water vapour. It therefore requires a competent seal to ensure that the steam remains underground. NSAI has flagged up seal competency as the greatest risk to the pilot given the relatively shallow nature of the reservoir, however the independent consultant has still attributed a confident 80% chance of success to the pilot project.
Figure 7: Extensive inventory of equipment in-place at Tsimiroro

Source: Mirabaud Securities.

The 2012 pilot will utilise 16 producers and 9 multi zone injectors over nine one-acre patterns. Madagascar Oil expects the pilot to be capable of producing at peak rates of 1,200 bopd, with a steam rate of 1,000 barrels of cold water equivalent per day. For this production the plant will consume 15-25% of the oil produced in heating the reservoir (see Figure 8). Currently equipment is being ordered, facilities being constructed and a team assembled in preparation for the project. Production is anticipated to commence in Q4 2012, and take 12 to 18 months to stabilise, after which a decision on project sanction will be made.

Figure 8: Tsimiroro pilot expected production

Source: Mirabaud Securities estimates.

Resources on the rise

Parallel to the pilot projects, Madagascar Oil is delineating the Tsimiroro field, with a view to increasing the overall resource base, as well as moving prospective resources into the contingent category. Because of the shallow depths of the reservoir, seismic data is often of low quality, and therefore Madagascar Oil has been using Electrical Resistivity Tomography (ERT) to identify sites for appraisal drilling.
ERT is a sub-surface imaging tool which identifies variations in electrical resistivity in the shallow sub-surface, and has been used with success at Tsimiroro, producing anomalies which are more or less consistent with the core data. In last year’s drilling campaign, 18 of the 24 wells encountered oil, prompting NSAI to lift best estimate in place contingent resources by 75% and best estimate prospective resources by almost 180%. Next year Madagascar Oil plans to drill wells into new areas flagged up during the 2010 ERT survey, which could result in further upgrades to the current 2C resource estimates.

<table>
<thead>
<tr>
<th>Resource category</th>
<th>Contingent recoverable</th>
<th>Prospective recoverable</th>
<th>Total recoverable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1C/low est.</td>
<td>1,100</td>
<td>770</td>
<td>1,464</td>
</tr>
<tr>
<td>2C/best est.</td>
<td>1,688</td>
<td>1,182</td>
<td>2,714</td>
</tr>
<tr>
<td>3C/high est.</td>
<td>2,459</td>
<td>1,721</td>
<td>6,532</td>
</tr>
</tbody>
</table>

Source: NSAI, Mirabaud Securities. *assuming 70% recovery factor.

Development plans

Although Madagascar Oil will have a better idea of its development plans following the steam flood pilot, given the similarities with Kern River, the Chevron-operated heavy oil field in California (see Appendix 5), and the experience and familiarity of the senior management with this field, a similar development approach is likely to be undertaken at Tsimiroro.

Management expects the field to be developed using steam-flood methods, although cyclic steam stimulation (CSS) will probably be used on the initial producers while waiting for the heat to reach the producing wells (this may take up to a year). The steam flood has several advantages over CSS, the most obvious being a 70% recovery factor – 4 times greater than CSS. Other advantages are simplified operations (single purpose wells), more efficient heating (one zone’s heat loss is the adjacent zone’s gain) and the ability to access multiple layers at once.

The field will be developed with ‘patterns’ of wells, each pattern consisting of one vertical producer and one vertical injector over a 2-acre area. The early wells will concentrate on the main TO1 prospect area, with the areas furthest from TO1 to be drilled last. In total between 6,000 and 10,000 steam/producer well pairs will be required for a full-field development – the drilling of which would span 20 to 30 years.

Produced water will be recycled in order to generate steam to be used in extraction, with any excess water produced disposed of through disposal wells. Back-up water in the case of a shortage will be sourced from water wells.
Infrastructure

Given the immaturity of the Madagascan petroleum industry the development of Tsimiroro will involve a major facility installation. This will include not only field-specific facilities, including central processing, steam generation, visbreaker upgrader and syncrude pumping stations, but also more general infrastructure, including transport links, a distribution grid and electrical power generation facilities.

Tsimiroro is situated approximately 125 km from the shoreline, from which oil will be exported. Two pipelines will connect the field to the coast; one field-to-shore syncrude pipe, and one shore-to-field diesel pipeline (diesel will be required to facilitate start-up). Major infrastructure installation will be needed at the shore. A tank farm, export facility, camp, upgraded port and tugboats will be required; in addition an offshore buoy and mooring station will be installed for docking, loading and unloading tankers. This will be connected to the terminal via a 30 km syncrude terminal-to-offshore pipeline, and a diesel offshore-to-terminal pipeline.

Production

NSAI’s best estimate of future production based on recoverable resources of 1.2bn bbls in four core structures of the field peaks at a rate of nearly 160k bopd, equivalent to 58 mmbbls per annum. In order to develop these quantities of oil the CPR estimates that capital expenditure of US$6.2 per barrel would be required totalling US$7.6bn, US$1.5bn of this prior to field start-up.

Figure 11: Tsimiroro schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Planned activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2012</td>
<td>Steam flood pilot construction</td>
</tr>
<tr>
<td>2012</td>
<td>Drilling c.25 wells plus 200 km ERT survey</td>
</tr>
<tr>
<td>2012-2014</td>
<td>Steam flood pilot operation and evaluation</td>
</tr>
<tr>
<td>2015-2017</td>
<td>Development design, construction and installation of first commercial phase</td>
</tr>
<tr>
<td>2017-2018</td>
<td>Full field production</td>
</tr>
<tr>
<td>[2018-2036]</td>
<td>Continuous development drilling at rates of 100 to 700 well pairs per year</td>
</tr>
<tr>
<td>[2053]</td>
<td>Abandonment and site restoration prior to concession termination in 2066</td>
</tr>
</tbody>
</table>

Source: Madagascar Oil, Mirabaud Securities estimates.

The key objective for Madagascar Oil is to prove production on a commercial scale. Although this is a very immature industry, and infrastructure and export facilities will need to be installed up front, the field can at least be developed incrementally, i.e. revenue can be generated from a small plant, which can be built upon in stages, as a result slowly ramping up to full production.
Exploration opportunities

Bemolanga

Bemolanga licence 3102 is situated to the north of Tsimiroro, and covers 5,463 km² (Figure 12). Madagascar Oil owns 40% of the licence, having farmed-down 60% equity and operatorship to Total in 2008 for US$100m in cash and a US$100m carry. The licence contains the 2bn barrel (in-place) Bemolanga bitumen deposit.

Figure 12: Bemolanga

Source: Madagascar Oil.

Work on the licence to date has focussed on the bitumen deposit. Over the past two years Total and Madagascar Oil have been exploring the possibility of a capital intensive mining project to extract the oil. However, due to the oil content of the Bemolanga sands being half that of similar developments such as Athabasca, the partners recently concluded that the development was not currently economical.

The decision to drop the oil-sand mining project is perhaps not hugely surprising. Independent auditor Norwest Corporation calculated a break-even oil price of over US$110/bbl (assuming a 12% discount rate) in a CPR compiled prior to IPO. Encouragingly however, Total remains optimistic about the prospectivity of the block, and in May the pair agreed an extension to the exploration phase with the Malagasy government, which would allow time to pursue the untested conventional oil play in the deeper part of the stratigraphic section. The companies are conducting an 8,600 km airborne FTG survey, which will tie in with the survey over the Tsimiroro acreage to the south. If the results are positive, there is an option for a two-year extension of the licence to allow for exploration drilling. Total will carry Madagascar Oil throughout the first US$10m (gross) to be spent on exploration.

Southern licences

Madagascar Oil also has wholly-owned interests in three exploration blocks located to the south of Bemolanga and Tsimiroro. Blocks 3105 (Manambolo), 3106 (Morondava), and 3107 (Manandaza) contain numerous conventional prospects containing estimated volumes ranging between 240 and 500 mmbbls.

The three licences were subject to the government takeover approach alongside the Tsimiroro asset, and although the issues surrounding the latter have since been resolved, the exploration licences remain under “force majeure” status. Madagascar
Oil is expecting to speak with the Government shortly to address the 2011-2012 work programmes and other outstanding issues on the blocks; however these assets lie low on Madagascar Oil’s list of priorities, and the hiatus of activity on the blocks has no adverse effect on the business (while under force majeure). Consequently, Madagascar Oil is in no real rush to continue exploration on these blocks.

**Figure 13: Southern licences**

![Map of Madagascar showing southern licences](image)

Source: Madagascar Oil.

**Block 3105 – Manambolo** covers an area of 3,995 km² on the central western coast of the country. Six wells have been drilled on the licence since 1971, with the latest in 1993 by OMNIS. Of the 6 wells, 5 showed signs of gas, with one well flowing at 15.6 mmcf/d on drill stem test. In addition, two of the wells encountered oil shows. Madagascar Oil will focus its exploration on Cretaceous sequences in two main prospects, with further geophysical studies required before any wells are drilled.

**Block 3106 – Morondava** is located immediately to the south of Manambolo, and covers 6,825 km². Only two wells have been drilled in the region, one of which encountered live oil and traces of gas in the mid-1980s. As with Manambolo there are no prospects ready to be drilled.

**Block 3107 – Manandaza** lies directly to the east of blocks 3105 and 3106, and covers 6,580 km². The block has been explored with just two wells, with one making a discovery of light oil. Although the well was successfully tested, it was deemed non-commercial after flowing just 10 bbls of 41° API oil from a very poor reservoir. Of the exploration licences, Manandaza is arguably the most exciting given the presence of moveable, light oil. More work is required to search for local lookalikes with better reservoirs, or to consider options regarding production enhancing techniques to improve reservoir performance.
Last year, Madagascar Oil performed a microseepage survey in seven areas across the southern licences. The survey is a low-cost, fast and effective process which uses a membrane similar to that found in Gore-Tex jackets (in-fact made by the same company), which traps any hydrocarbon molecules which are leaking to the surface. Three of the seven areas (3107 Area 1, 3105 Area 2, and 3106 Area 2) showed good indications of hydrocarbon accumulation, two had poor presence (3105 Area 1 and 3106 Area 1), and two areas were inconclusive (Areas 2 and 3 in 3107). Although the data is currently being reprocessed, the indications of hydrocarbons is clearly encouraging, and Madagascar Oil plans to return to the areas from which positive microseepage results were measured to perform an FTG gradiometry programme later this year. If a drillable prospect is identified, we expect drilling to commence in the block during 2013, subject to resolving outstanding issues with the Government.
Valuation

Total NAV of 147p/shr

We have valued Tsimiroro at US$830m based on a DCF analysis of the field’s independently-verified best estimate contingent resources, using a 12% discount rate and long term oil price of US$85/bbl flat nominal (for more detail see valuation assumptions in Appendix 1). We have ascribed a chance of success of 50%, reflecting the technical chance of success associated with the steam flood (80%), discounted further to allow for timing delays, cost over-runs etc.

We have chosen to include only the contingent resources in our valuation, and have omitted any value for the c.1.5bn of mean prospective recoverable resource base at Tsimiroro. Our approach is conservative, and we can see considerable upside as contingent resources are shored.

Exploration upside

Due to the early stage of exploration in the Bemolanga block and the three southern exploration licences, we are ascribing zero value to these assets in our total NAV. We believe that these assets may have considerable future potential, however without drilling results and resource estimates it is difficult to pin a value on the assets, at this stage.

Figure 15: Valuation

<table>
<thead>
<tr>
<th>Asset name</th>
<th>Working Interest</th>
<th>Net mmboe</th>
<th>USD/boe</th>
<th>Unrisked</th>
<th>p/share</th>
<th>CoS</th>
<th>Risked</th>
<th>USD$m</th>
<th>p/share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsimiroro contingent resource</td>
<td>100%</td>
<td>1,182</td>
<td>0.59</td>
<td>829.9</td>
<td>253.4</td>
<td>50%</td>
<td>414.9</td>
<td>126.7</td>
<td></td>
</tr>
<tr>
<td>Add: cash (FYE 2010)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>56.0</td>
<td>17.1</td>
<td></td>
<td>56.0</td>
<td>17.1</td>
<td></td>
</tr>
<tr>
<td>Add: options &amp; warrants</td>
<td></td>
<td></td>
<td></td>
<td>8.7</td>
<td>2.7</td>
<td></td>
<td>8.7</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td><strong>Total NAV</strong></td>
<td></td>
<td></td>
<td></td>
<td>894.6</td>
<td>273.2</td>
<td></td>
<td>479.7</td>
<td>146.5</td>
<td></td>
</tr>
</tbody>
</table>

Source: Mirabaud Securities estimates. 1Million barrels, best estimate economically recoverable resources, Mirabaud estimate. 2Chance of success.

Valuation sensitivity

Our Tsimiroro valuation is highly sensitive to both discount rate and oil price variations, principally due to the high development costs and long lead time to peak production. For instance, if we were to use US$100/bbl oil and reduce our discount rate to 10%, our NAV would increase to 372/shr. This illustrates one of the key investment attractions of Madagascar Oil, namely its status as a highly leveraged resource play.

Figure 16: Tsimiroro risked NAV sensitivity

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8%</td>
<td>213</td>
<td>341</td>
<td>458</td>
<td>575</td>
<td>691</td>
<td>806</td>
</tr>
<tr>
<td>10%</td>
<td>115</td>
<td>205</td>
<td>289</td>
<td>372</td>
<td>456</td>
<td>539</td>
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<tr>
<td>12%</td>
<td>51</td>
<td>116</td>
<td>177</td>
<td>239</td>
<td>299</td>
<td>360</td>
</tr>
<tr>
<td>15%</td>
<td>(5)</td>
<td>37</td>
<td>77</td>
<td>116</td>
<td>156</td>
<td>195</td>
</tr>
</tbody>
</table>

Source: Mirabaud Securities estimates.
Funding

Cash – the most valuable commodity

At mid-year Madagascar Oil had cash reserves totalling US$54m. The company expects that this level of funding will see it through to at least mid-2013, at which point the steam-flood project will be up and running and the potential of Tsimiroro will be clearer.

**Figure 17: Use of funds (to mid-2013)**

![Use of funds (US$m)](image)

Source: Madagascar Oil.

The company will also continue exploration operations at the Bemolanga block at no cost, via a US$10m (gross) carry by operator Total. The carry will cover costs until at least mid-2012.

**Figure 18: Use of funds (to mid-2013)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Location</th>
<th>Date</th>
<th>Cost (US$m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling</td>
<td>Tsimiroro</td>
<td>2011-2012</td>
<td>3</td>
</tr>
<tr>
<td>FTG and ERT</td>
<td>Tsimiroro</td>
<td>2011-2012</td>
<td>2</td>
</tr>
<tr>
<td>Steam flood facilities</td>
<td>Tsimiroro</td>
<td>2011-2012</td>
<td>28</td>
</tr>
<tr>
<td>Steam flood operation</td>
<td>Tsimiroro</td>
<td>2012-2013 (9 mths)</td>
<td>6</td>
</tr>
<tr>
<td>FTG</td>
<td>Expl blocks</td>
<td>2012</td>
<td>3</td>
</tr>
<tr>
<td>Seismic</td>
<td>Expl blocks</td>
<td>2013</td>
<td>3</td>
</tr>
<tr>
<td>Working capital</td>
<td>n/a</td>
<td>2011-2013</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: Madagascar Oil.
Appendix 1: Tsimiroro valuation assumptions

Modelling approach

We have built an asset model of the Tsimiroro steam flood project based on the current best estimate contingent resources of 1,182 mmbbls. The model assumes first full production in 2018, with a gradual ramp up to a peak rate of almost 160 kbopd in 2035 (see production profile in Figure 19).

- Drilling: we have assumed that full field development requires some 6,850 production wells, and an equal number of injectors. We expect each producer to peak at an annual average rate of 82 bopd in year two before undergoing natural decline, with a total drainage per well of less than 0.2 mmbbls. We have assumed that approximately US$3.2bn is spent on drilling and completion activities in total.

- Infrastructure: As discussed earlier in the note, the Tsimiroro field will require considerable investment in infrastructure, including central processing facilities, steam generation, and visbreaker upgrader, as well as extensive pipelines and coastal export facilities. We have assumed US$3.4bn of facilities capex over the field life, and a further US$1bn of pipeline and other non-drilling expenditure.

Figure 19: Tsimiroro field production profile

Source: Mirabaud Securities estimates.

The Tsimiroro field is a relatively high cost operation principally due to the energy-intensive nature of the stream generation process. We have assumed that, on average, 22.5% of gross oil production is used to power in-field facilities. In addition, we have assumed a further US$45m per annum of fixed operating costs and US$3/bbl of variable costs. Another issue impacting the economics of the project is the sales price of the field’s heavy oil, which we have assumed achieves a discount to Brent of 29% – in-line with the CPR and a marketing survey carried out by the company.

Figure 20: Tsimiroro field asset model – Mirabaud estimates

<table>
<thead>
<tr>
<th>Field name</th>
<th>Economic recovery mmbbls</th>
<th>Brent discount</th>
<th>Capex US$/bbl</th>
<th>Opex US$/bbl</th>
<th>Unrisked NPV/12 US$m</th>
<th>Value per barrel US$/boe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsimiroro field</td>
<td>1,129</td>
<td>29</td>
<td>6.8</td>
<td>12.9</td>
<td>829.9</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Source: Mirabaud Securities estimates. 1Excludes cost of lost production used in operations.

The table above summarises the key inputs and outputs of our DCF analysis. Although we have modelled the entire contingent resource base, the field’s high fixed costs mean that project cash flows turn negative before the deposit is fully exploited. Hence, the economic oil recovery falls short of the field’s contingent resource figure.
Appendix 2: Madagascar – country overview

Overview

Madagascar, the world’s fourth largest island, is situated some 300 miles offshore south-east Africa in the Indian Ocean. The country has been an independent island republic since 1960, when it was granted freedom from French rule. Madagascar’s transition to democracy has not been the smoothest, and the country has experienced occasional political unrest over the last half-century, with the latest upset occurring in 2009 and only now in the process of being resolved. Despite these setbacks, the country’s economic output has continued to grow, with the emerging natural resources sector playing a major role.

Figure 21: Madagascar: Key facts

<table>
<thead>
<tr>
<th>Capital:</th>
<th>Antananarivo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Area:</td>
<td>587,041km²</td>
</tr>
<tr>
<td>Population:</td>
<td>2011 21.9m</td>
</tr>
<tr>
<td>Life Expectancy:</td>
<td>2011 64 years</td>
</tr>
<tr>
<td>GDP:</td>
<td>2010 US$19.4bn</td>
</tr>
<tr>
<td>GDP forecast:</td>
<td>2011 +0.6%</td>
</tr>
<tr>
<td></td>
<td>2012 +4.7%</td>
</tr>
<tr>
<td></td>
<td>2013 +4.9%</td>
</tr>
<tr>
<td></td>
<td>2014 +5.0%</td>
</tr>
</tbody>
</table>

Source: CIA World Factbook, World Bank, International Monetary Fund.

Geography and climate

Madagascar can be geographically divided into five regions: the east coast, the Tsaratanana Massif, the central highlands, the west coast and the southwest. The east coast comprises a surprisingly straight coastline, separated from an escarpment leading to the central highlands with a narrow band of lowlands roughly 50 km wide. The Tsaratanana Massif covers the north end of the island and forms the highest point at 2,880 metres. The terrain is mountainous, with volcanic geology. The central highlands cover the majority of the country. Ranging in altitude from 800 to 1,800 metres, the geology and geography is varied, from massive granite outcrops and extinct volcanoes, to rounded sedimentary hills. The capital city, Antananarivo is located in the central highlands, at approximately 1,468 metres above sea level. The west coast comprises layers of sedimentary deposits, forming many of the hydrocarbon reservoirs on the island. This coast also offers many more natural harbours than the east, and therefore has been an important hub in the development
of the country. The southwest of the island receives very little rainfall, and as a result is arid, to the extent that much of the region is covered in desert.

Madagascar has two main seasons; hot and rainy between November and April, and cooler and drier from May to October. Given the country's size and its exposure to the Indian Ocean the climate is, however, varied. The trade winds off the Indian Ocean bring rain, and sometimes cyclones to the east coast and central highlands. By the time the weather reaches the west coast, much of the humidity has gone, making the region much less susceptible to both cyclones and monsoonal rain.

In terms of climate, Madagascar Oil's west coast location is therefore preferable, however, the company believes that seasonality will affect start-up activities, with the bulk of the drilling and construction needing to be done during the dry season. Once the project is up and running, however, the seasonality should be inconsequential.

**Industry and economy**

After six years of strong growth, the Madagascan economy shrunk in 2009-10, but the IMF has forecast a return to growth in 2011, with yearly GDP growth of 4-5% forecast for 2012-15.

Industry in Madagascar is centred on textile manufacturing, agricultural products processing and tourism. There is a small, but growing natural resources sector, with graphite, chrome, bauxite, ilmenite, nickel, gold, petroleum, semiprecious stones, and hardwoods exploited to varying degrees. Agriculture contributes 29% of the country's GDP, with manufacturing, including processed food, textiles and paper making up 16%. Madagascar's main exports include apparel, seafood, vanilla, minerals and tobacco, with total exports amounting to approximately US$1.3bn. The country currently has a trade deficit of US$2.1bn, much of which is due to fuel imports – highlighting the importance of developing a domestic oil and gas industry.

![Figure 22: Paddy field in Antananarivo](image)

Source: Mirabaud Securities.

Madagascar currently meets its energy needs via imported hydrocarbons and small amounts of hydroelectric power generation. As a result the country has a large energy deficit, consuming approximately six times the amount that it generates.
Geology

The existence of heavy oil in Madagascar has been known for hundreds of years; however, despite numerous surveys and the drilling of more than 500 wells commercial production has yet to be established, primarily due to low historic oil prices, and the country’s remote location. The emergence of the heavy oil industry, particularly in Canada and Venezuela, has resulted in significant advancements in bitumen extraction technology. The availability of this technology, along with a push for foreign investment in natural resources by the Government and the World Bank has prompted significant international interest in this expansive resource.
Madagascan hydrocarbon plays comprise Permian, Triassic, and Jurassic rift graben sediments of the Karroo sequence, which are formed of continental beds, sandstones and lake-deposited shales predominantly located to the west of the island (Figure 24). The Sakoa, Sakamena Isalo, and Amboloando Formations make up the sequence, with rich hydrocarbons source rocks provided by the Sakamena Formation, and the Isalo and Amboloando Formation sandstones and shales commonly acting as a reservoir and seal. The hydrocarbon system is non-complex, with short migration paths for the thermally mobilised oil.

The high densities that characterise Madagascan oil were acquired during the Tertiary, when the overlying sediment was deeply eroded, exposing the reservoir to meteoric water and releasing much of the light components of the oil. The degree of erosion was local, resulting in variations in the API density seen in the reservoirs today. At Bemolanga for example, much of the shale seal was breached, and the surface or near-surface oil was converted into ultraheavy oil. On the other hand at Tsimiroro the erosion was less severe, and the shale seals remained intact. As a result the oil at Tsimiroro was less drastically altered.

**Political uncertainty**

Madagascar was under French control from 1896 until it gained its independence in 1960. Since then, the country has experienced something of a chequered political history. The first president, Philibert Tsiranana, governed for 12 years, before stepping down in response to civil unrest in 1972. A succession of military rulers followed, as the country began to move away from French influence with increasingly communist-inspired policies. In 1975 Didier Ratsiraka came to power in a coup d’état. He was to remain in power for 16 years; under his rule Madagascar moved further towards socialism and his tenure saw the nationalisation of many private enterprises, but was marked by economic decline.

Ratsiraka’s power was significantly undermined in 1991, as the capital saw mass protests and general strikes, and a date was set for a presidential election. Although losing the multiparty election held in 1992-93, Ratsiraka was able to return to power again in 1997. The following presidential election saw Ratsiraka running against Marc Ravalomanana in 2001. Both candidates claimed victory, resulting in further violence and political unrest which saw major transport routes from the primary port to the capital city interrupted. In 2002 Ratsiraka fled into exile in France leaving the presidency to Ravalomanana.

Despite early popularity, allegations of fraud surrounded Ravalomanana’s tenure, culminating with Madagascar’s major international aid donors suspending their support in December 2008 amidst allegations of budgetary misconduct with the president accused of mixing state and personal business interests. Violent political protests followed and in January 2009 Andry Rajoelina, a former DJ and then mayor of capital city Antananarivo demanded that Ravalonamana step down. In March 2009, amidst growing protests and following a loss of support from the army, Ravalomanana was forced to flee, and the army handed over power to Rajoelina.

Since assuming presidency, Rajoelina’s popularity has waned and progress towards democratic elections has stalled. The international community viewed Rajoelina’s ascent to power as an effective coup d’état, and Madagascar has been the subject of censure and sanctions, as well as the suspension of international aid and calls for dialogue and elections.
In 2011, the Southern Africa Development Community (SADC) attempted to broker a deal to pave the way to democratic elections. The inter-governmental organisation, whose objective is political liberation of Southern Africa, set up an office in Antananarivo and worked closely with all of the Malagasy political parties in forming a resolution to the situation. A political roadmap to democratic elections was established, and in September 2011 all three main parties, including Rajoelina and Ravalomanana agreed to elections within a year. The deal allowed for the unconditional return of the exiled opposition leader Ravalomanana, and in the signing of the document, the international community has, for the first time, recognised Rajoelina’s leadership (albeit in a temporary capacity). At the time of writing, there is no indication as to when the sanctions and aid suspensions will be lifted, however the recognition of Rajoelina’s government is an important step forward.

Natural resources sector

In recent years, economic activity in Madagascar’s natural resources sector has gained momentum and a number of large companies now hold interests in the country’s licences. On the mining side, two multinational mining companies, Rio Tinto and Sherritt International, are active in country, while in the oil and gas sector, supermajors such as Total and ExxonMobil hold acreage, alongside a long list of independents including Tullow Oil, Sterling Energy, Afren and Niko Resources, among others.

Key to the relative steadiness of activity in the sector has been the presence of a stable interface between the government and foreign companies investing in Madagascar’s natural resources. OMNIS (Office des Mines Nationales et des Industries Stratégiques) has been regulating the industry since 1976, facilitating progression despite the underlying political problems.

OMNIS has responsibility for providing policy guidance and drawing up legislation in the sector, while also conducting research into exploration and exploitation of mineral resources. In addition the body is tasked with promoting the development of the petroleum and mining sectors and holds responsibility for licensing.

In part because of the role played by OMNIS, operators have continued to push ahead with investment and production in the country, despite the political issues. In the mining sector, Sherritt is forging ahead with its US$2.1bn development of one of the biggest lateritic nickel projects in the world, and mechanical completion is expected next year. Rio Tinto, meanwhile, has been producing ilmenite since 2009 from its US$1.1bn facility at the south-easterly tip of the island.

OMNIS is looking to hold a major oil exploration licensing round in the near future, aiming to offer up half of its 296 available oil blocks. The first 50 of these were supposed to be auctioned in 2009; however the political crisis has delayed the licensing round, which is not expected until after the presidential vote in 2012. Mines and Oil Minister Mamy Ratovomalala has stated that he wants to ensure confidence in the government from the international community before offering the permits, in order to maximise interest.
Appendix 3: Fiscal terms

Tsimiroro

The primary lease term for licence 3104 is 25 years from first sales, with provisions for five extensions of five years each.

The exploration stage of the Tsimiroro license is due to expire in August 2012, at which point Madagascar Oil is expected to be mid-way through the steam-flood pilot. The company is permitted to ask for a two year extension; however, the application cannot be submitted until after the pilot has started.

Figure 25: Tsimiroro royalty rate

![Royalty rate graph]

Source: NSAI, Norwest.

Royalties on oil production are payable based on sales price (Figure 25), excluding oil consumed internally during the production process.

Figure 26: Tsimiroro profit share scale

<table>
<thead>
<tr>
<th>Year of production</th>
<th>0-10</th>
<th>10-20</th>
<th>20-30</th>
<th>30-40</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMNIS share of profits</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Source: NSAI

The Madagascan government, through OMNIS, operates a profit sharing scheme in which the oil revenue (minus royalty, fuel losses and cost oil) is shared on a sliding scale between the private companies and the government. The scale is dependent on the year of production, summarised in Figure 26. Finally, the country demands a flat 23% Indirect Hydrocarbon Tax, applied to profit oil.
Appendix 4: Steam injection

The steam injection technique is the most widely implemented enhanced oil recovery method. It is commonly used on shallow, immobile oil fields and works on the principle that an increase in the temperature of the reservoir will decrease the viscosity of the oil within, and consequently result in the oil being able to flow. While this method is expensive, it is also hugely effective with typical recovery factors of over 60%. During the process the reservoir is heated in situ to between 300°F and 400°F by injecting steam into the reservoir. This lowers the viscosity down to a manageable 10-20 centipoise, at which point it can be drawn to the surface along with the condensed water. This mixture is piped to a central processing facility (CPF) where it is separated, and the still-hot water re-cycled through the steam generators.

The amount of time it takes for the steam to reach the producing wells is called the Neuman time. A typical Neuman time is 8-18 months, depending on the well spacing and reservoir quality – projects that have Neuman times of two years or more tend to fail. Once the steam has broken through, the rate of injection is regulated to make sure that heat loss through the producers is minimized.

Steam oil ratio (SOR)

Steam injection projects use the parameter of steam-oil-ratio (SOR) to assess relative efficiency. The SOR is usually expressed in terms of barrels of steam (more precisely the number of barrels of water used to create the steam) injected per barrel of oil recovered. Typically an SOR lower than 8-10 would be commercial; obviously the lower the number, the more desirable the project.

The efficiency of heating is a key parameter affecting the SOR, and therefore the commerciality of the project. The best fields for the technique have relatively thick oil zones, high porosity and oil saturations and are geologically homogenous (i.e. few interbeds). Efficiency is improved by minimising heat losses by heating and maintaining the reservoir to the required temperature and no further, facilitated with observation wells and minimal distances between the wells.

Once the heavy oil has been extracted it will soon return to its ambient temperature, at which point it will again become immobile. In order to permanently decrease the viscosity to allow for ease of transport, either diluents are added, or the oil is processed at a visbreaking unit.

There are two main types of steam injection; steam-flood, and cyclic steam stimulation. The processes rely on the same principles; however, they differ in their efficiencies and cost.

Steam-flood

Steam-flood involves a steam injector well with one, or a number of associated producers. The injector well pumps steam into the reservoir, which warms the oil and drives it in the direction of the producer. The most common way in which a steam-flood fails is because either it is too deep, so the reservoir cannot be effectively heated, or there is an active aquifer which is removing warmth from the reservoir.

A typical steam flood consumes around 25% of the produced oil to make steam in the early stages, falling to around 15% over time. After 10-15 years of steam injection, the reservoir builds up latent heat, which will allow the field to produce for some time after. Overall recovery factors can be improved with additional processes forcing the oil in the direction of the producers, either with CO₂ or simply with gravity.
Steam assisted gravity drainage (SAGD) has become popular in Canada, in which a horizontal producer is drilled beneath a steam injector. The reservoir surrounding the injector is heated to the point at which gravity will force the oil into the producer (Figure 33). It is worth noting that SAGD is not applicable to all fields. The reservoir at Tsimiroro has a number of shaley interbeds, fault traces and igneous intrusions which may physically separate injector wells from the producer, and therefore SAGD would not be feasible in this case.

Cyclic steam stimulation (also known as CSS or “Huff and Puff”), involves three discrete stages; injection, soaking, and production. Unlike steam-flood techniques only one well is required; however, the recovery rates are substantially lower. Initially steam is injected into the reservoir to lower the viscosity of the oil to a point at which it can flow. The well is then suspended for a couple of days to allow the steam to soak in, after which the same well is put onto production and the mobilised oil is extracted. Typically at Tsimiroro a 10-day injection stage will allow for 120-150 days production, with artificial lift required after 1-3 days flowing. It is not uncommon for steam-flood techniques to be used in conjunction with CSS – a well will often be produced using CSS for a few cycles before being put on a steam flooding regime with other wells.
Figure 29: Cyclic Steam Stimulation (CSS)

Stage 1:
Steam Injection
Steam is injected into reservoir

Stage 2:
Soak phase
Steam and condensed water heat the viscous oil

Stage 3:
Production
Heated oil and water are pumped to the surface

Source: Canadian Centre for Energy Information.
Appendix 5: Kern River – a steam-flood analogy

Kern River is a Chevron-operated heavy oil field situated in the San Joaquin Valley in California. The field is the fifth largest in the US, and produced over 29 mmbbls of oil in 2009. The field is also one of the most prolific globally having produced over 2 billion barrels, with Chevron expecting to extract a further 1.5 billion barrels before abandonment.

14° API oil is extracted at Kern River through 8,700 producing wells, each producing an average of approximately 10 bbls/d. The field utilises steam-flooding techniques, as well as horizontal drilling and CO₂ injection to maximise production. Oil is found within Upper Miocene-Pliocene, Kern River Formation sandstones at depths of less than 1,000 feet.

At Kern River, Chevron purchases large amounts of natural gas (amounting to approximately 50% of the field’s opex) which is used to generate steam at its two cogeneration (CHP) plants, as well as electricity to power the field. The plants have a 300 MW generating capacity of which just 36 MW is used on the field, with the remainder sold to the state grid. In addition, the plants produce approximately 250,000 bbls/d of steam each, which is then injected into the reservoir.

Over 650 observation wells have been drilled to constantly monitor the saturation and the temperature of the reservoir. These allow Chevron to target regions where steam is most needed in order to maintain healthy flow rates, and to minimise the SOR of the field.

Figure 30: Kern River (observation wells, red dots; producers and injectors, black dots)

The field has long been a training ground for petroleum engineers, with many modern enhanced recovery techniques honed there. The good news for Madagascar Oil is that development plans for Tsimiroro can closely follow those trialled at Kern River since the 1960s (when steam-flood was introduced), due to similar reservoir and fluid properties outlined below.

The development of Tsimiroro is planned with a small spacing pattern of vertical wells similar to those at Kern River. The Amboloando Sand has a similar character to the Kern River sands, which comprise several sand bodies separated with 5-20 foot thick shale intervals. The depths of the reservoirs differ however; and given Tsimiroro’s shallower lying sands, local steam chamber seal integrity may be an issue. Other minor differences when comparing the two fields include a lower porosity at Tsimiroro, which is offset by a higher initial oil saturation resulting in a generally
lower range of oil content per unit of reservoir volume. The oil zone at Tsimiroro is thicker, which is favourable for thermal efficiency; however, the oil will need to be lifted to a higher temperature than at Kern River in order to flow. Finally the permeability at Tsimiroro is lower than at Kern River, but is still sufficiently good for injection rates as proved during the 2008 CSS pilot.

**Figure 31: Tsimiroro and Kern River comparison**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Kern River</th>
<th>Tsimiroro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formation depth below surface (feet)</td>
<td>700-770</td>
<td>100-250</td>
</tr>
<tr>
<td>Porosity</td>
<td>35%</td>
<td>24%-26%</td>
</tr>
<tr>
<td>Initial oil saturation</td>
<td>50%</td>
<td>53%-57%</td>
</tr>
<tr>
<td>Oil content</td>
<td>1,400</td>
<td>1,000-1,400</td>
</tr>
<tr>
<td>Net pay (feet)</td>
<td>70</td>
<td>100-150</td>
</tr>
<tr>
<td>Permeability (md)</td>
<td>7,600</td>
<td>500</td>
</tr>
<tr>
<td>Initial formation pressure (psig)</td>
<td>60-70</td>
<td>50-60</td>
</tr>
<tr>
<td>Initial formation temperature (°F)</td>
<td>80-85</td>
<td>82-85</td>
</tr>
<tr>
<td>Steam chamber temperature (°F)</td>
<td>300</td>
<td>310-320</td>
</tr>
<tr>
<td>Oil gravity (°API)</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Oil viscosity (cp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at 85°F</td>
<td>2,700</td>
<td>N/A</td>
</tr>
<tr>
<td>at 140°F</td>
<td>N/A</td>
<td>4,600</td>
</tr>
<tr>
<td>at 212°F</td>
<td>N/A</td>
<td>360</td>
</tr>
<tr>
<td>at 350°F</td>
<td>4</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source: NSAI.
Appendix 6: Management

Executive Directors and Senior Management:

John Laurie Hunter, Chairman and Chief Executive Officer

Laurie Hunter, aged 64, has been a director of Madagascar Oil since October 2008, and became CEO in July 2009. Previously he was the founder of Hunter Capital LLC, which focused on investing in early stage energy companies and assisting them to raise finance and generate growth. Mr. Hunter has served on the board of a number of private North American based E & P companies and has been both a limited and a general partner of a number of private drilling partnerships in the United States. In addition, Mr. Hunter is currently an independent director of Living Cell Technologies Limited (ASX-LCT), a New Zealand based biotechnology company. Mr. Hunter holds an MA in Politics, Philosophy and Economics from Oxford University.

Mark Field Weller, Chief Operating Officer

Mark Weller, aged 61, has been with the Company since 2008, after serving five years as President of a small independent Texas oil company. He has over 39 years of oil industry experience with an extensive background in domestic and international oil and gas development (both onshore and offshore drilling and production operations), including 15 years direct involvement with the design, initiation and operation of heavy oil steam flood projects in California. Mr. Weller has previously worked with Texaco and Getty Oil in a variety of positions throughout the United States and worked internationally developing projects in West Africa. Mr. Weller has a Bachelor’s degree in Mechanical Engineering from the University of California, Davis.

Seth Fagelman, Chief Financial Officer

Seth Fagelman has served as the Company’s Chief Financial Officer since December 2009. He has significant financial and business experience, having previously held CFO and senior management positions for CyrusOne, Prime Cable and GW Communications. He currently serves as a strategic adviser and board member to several private companies. Mr. Fagelman has helped raise over US$1.7 billion in debt and equity capital to finance acquisitions and growth in the telecommunications, technology, manufacturing and distribution sectors. Mr. Fagelman graduated with an MBA from the University of Texas, Austin.

Gil Melman, General Counsel

Gil Melman became the General Counsel of the Company in March 2011. From August 2008 through February 2011, Mr. Melman was seconded to the Company to act as general counsel. During that time, Mr. Melman was a partner at Selman, Munson &Lerner P.C., a Texas based law firm specializing in corporate transactional work. Prior to joining Selman, Munson & Lerner P.C., Mr. Melman was employed as Vice President of Legal at a regional private equity fund and also as Vice President and Assistant General Counsel at a large Fortune 100 energy company. Mr. Melman began his career at Vinson & Elkins LLP, as a lawyer in its Corporate & Securities Group. Mr. Melman obtained his Bachelors of Business Administration and his Juris Doctor Degrees from the University of Texas, Austin.
Alvaro Kempowsky, General Manager – Madagascar

Alvaro Kempowsky is the General Manager of Madagascar Oil SA, having joined from Chevron Corporation in early 2007. Mr. Kempowsky spent much of his career as a Project and Operations Manager with Texaco in Colombia and Angola, including responsibility for, inter alia, operations and construction of heavy oil, light oil and natural gas developments. In addition, Mr. Kempowsky spent 14 years as the project manager for a new heavy oil steam project in Colombia for Texaco and Ominex. Mr. Kempowsky has a M.E. in Petroleum Engineering and an M.E. in Engineering Management from the University of Tulsa, Oklahoma. He also has a degree in Electrical Engineering from the National University of Colombia.

Dr. Emma Ralijohn, Deputy General Manager – Madagascar

Dr. Emma Ralijohn is Deputy General Manager of Madagascar Oil SA, having joined in 2007, and is primarily responsible for working with government authorities for contract and environment requirements. She has been a faculty member for a leading Business School in Madagascar since 1991. Prior to joining the Company, Dr. Ralijohn served as Finance Adviser to the President of Madagascar. She led her country in obtaining the first ever signed Compact with the USA-funded Millennium Challenge Account (MCA) and was named CEO of the entity set up to manage the US$110 million fund. She has served as a Director in the Banking and Financial Supervision Board of the Central Bank since 2005. She is the President of the Upstream Oil Companies Association and the Vice-President of the American Chamber of Commerce in Madagascar. Dr. Ralijohn has a Ph.D. in Finance and a Doctorate ès Sciences de Gestion in Strategic Management.

Jim Lederhos P.E., Chief Engineer

Jim Lederhos is Chief Engineer for the Company, having joined in 2008 from Chevron, where, over a 27 year career, he was involved in all aspects of steam flood design and evaluation of heavy oil projects worldwide, including California and Indonesia. Mr. Lederhos has co-ordinated all aspects of the Tsimiroro Field project design and evaluation for thermal testing. He has also served as a consultant for several heavy oil projects worldwide in the last several years. Mr. Lederhos has B.S. degrees in Engineering and Geology from Oregon State University in Corvalis, Oregon.
RECOMMENDATIONS HISTORY

<table>
<thead>
<tr>
<th>Date</th>
<th>Market Index Level</th>
<th>Share Price (p)</th>
<th>Target Price (p)</th>
<th>Opinion</th>
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<tr>
<td>27 Jun. 2011</td>
<td>4,139.1</td>
<td>35</td>
<td>105</td>
<td>BUY</td>
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<td>12 Jul. 2011</td>
<td>4,335.3</td>
<td>47.63</td>
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<td>BUY</td>
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<td>7 Oct. 2011</td>
<td>3,060.7</td>
<td>26.88</td>
<td>125</td>
<td>BUY</td>
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</tbody>
</table>

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ACCUMULATE: The stock is expected to generate absolute positive price performance of 10-20% during the next 12 months.

NEUTRAL: The stock is expected to generate absolute price performance of between 10% positive and 10% negative during the next 12 months.

REDUCE: The stock is expected to generate absolute negative price performance of 10-20% during the next 12 months.

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