build existing US rockets. The rocket project is financed by Musk himself, and if it works as advertised, there's a real chance that SpaceX could offer to launch payloads at a lower cost than existing options.

But that would be only half the battle. The main things constraining the development of new launch options are the low number of customers and the emphasis that these customers place on reliability, as opposed to cost.

Government agencies are by far the largest customers for rocket launches, and they would like to bring costs down. But reliability remains a greater priority. Take a high-value payload such as the $4.5-billion James Webb Space Telescope planned for launch sometime in the next decade, or the $500-million New Horizons Pluto probe scheduled to take off from Cape Canaveral on an Atlas V rocket next month. When the satellite costs far more than the rocket ride, the project manager will pay extra to make sure the spacecraft is delivered safely to orbit. A few tens of millions of dollars in savings wouldn't matter much considering the cost of failure. Similar considerations influence operators of telecoms satellites, who can seldom afford to lose them or delay their arrival into space.

The only remaining customer potential lies with space tourism. But even assuming that a few dozen millionaires visit Earth orbit each year by 2020, the market will remain commercially insignificant. In any case, the space tourists — or at least their insurance companies — may also favour proven reliability over a cheap ticket.

Openings will still arise for the development of more space-launch options on the margins. NASA, for example, is now considering relaxing its traditional insistence on several layers of oversight and inspection for flights that will take food and water to the space station. The agency would instead pay for a delivery service and let the launch provider assume responsibility for the success of the launch.

"Even assuming that a few dozen millionaires visit Earth orbit each year by 2020, the market will remain commercially insignificant."

Such approaches will help to spur on people such as Musk and establish whether they can indeed build a reliable track record in the space-launch business. Until they have done so, the suggestion that entrepreneurial activity can make a substantial difference to the cost of space travel should still be considered pie in the sky. ■

Enough, already

No convincing case has been made for increasing the amount of plutonium held at a Californian lab.

The US Department of Energy is planning to double the amount of plutonium that can be stored at the Lawrence Livermore National Laboratory in California. Under new rules announced last week, the nuclear-weapons lab can keep up to 1,400 kilograms, or enough for around 300 bombs.

Not surprisingly, antinuclear activists are up in arms about having so much bomb-grade metal in such a heavily populated area. But researchers who want the US nuclear-weapons laboratories to set a good example for the rest of the world should be equally dismayed at the plan.

Since 1992, the United States has maintained a moratorium on the testing and development of new nuclear weapons. There's no real need for this research lab, which accommodates an outstanding civilian research programme next to its weapons-related activity, to be playing with this quantity of plutonium.

Livermore is expected to use some of the expanded inventory in nuclear-weapons research, including experiments at the National Ignition Facility (NIF), a massive laser facility that will recreate some of the conditions inside nuclear weapons at detonation. The facility's original function was to perform such experiments on hydrogen isotopes, rather than plutonium. Officials at the Department of Energy never formally excluded the option of using plutonium in the NIF, but a 1995 report prepared by scientists in the department's non-proliferation office warned that its use at the facility could be seen as provocative by other nations.

The other main reason why Livermore wants to hold more plutonium, according to energy-department documents, is that it will start to lay the groundwork for the renewed mass production of plutonium pits, used in US nuclear weapons. Livermore will be charged with developing new technologies for manufacturing the pits, for use at a proposed industrial-sized production facility. But questions remain over whether this facility is either necessary or appropriate, and this year Congress declined to appropriate the money needed to begin planning for its construction.

Most of Livermore's new plutonium stocks would be shipped there from the Los Alamos National Laboratory in New Mexico, where the Department of Energy's track record in handling plutonium does not inspire much confidence. According to a report released on 29 November by the Institute for Energy and Environmental Research, a watchdog group based near Washington DC, Los Alamos has managed to lose between 300 kg and 600 kg of the material over the years. The group suggests that much of it was dumped indiscriminately in the desert during the early days of the nuclear age, or was mislabelled when shipped off elsewhere for long-term storage.

"The laboratory is wasting its time researching pit production for a facility that may never actually be built."

And Livermore has had its own problems with plutonium. In January, its plutonium facility, where scientists work with the metal under heavily controlled conditions, was shut down amid safety concerns. Problems cited at the time included cracks in the building's ventilation systems and poorly constructed 'hot boxes' for handling the metal. The facility was allowed to reopen at a reduced capacity last month.

In light of all this, Livermore's plan to double its inventory of plutonium is ill-advised. A case for plutonium experiments at the NIF has not been made, even to review groups that have the security clearance needed to assess it. And the laboratory is wasting its time researching pit production for a facility that may never actually be built. For a mixed-use scientific facility in a residential area, 700 kg of plutonium is enough, already. ■