

Recommendations for a Danish National HPC Facility

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This recommendation has been prepared jointly by DCSC and PRACE grant holders in Aarhus University and the University of Southern Denmark.

The complete list of supporting scientists appears on page 3.

e-Science

Data generation and analysis using computational methods are at the heart of all modern science and technology. This discipline of using digital methods for generating ideas and knowledge from data, often referred to as e-science, is a key enabling technology for the advanced nations in the 21st century¹.

Increasingly the needs of industry and the public sector are the same as those of academia. At present, however, both academia and industry are unable to reap the advantages of e-science because of the lack of an appropriate e-infrastructure. *A national High Performance Computing (HPC) infrastructure is thought of as a strategic investment in all highly developed countries in Europe, America and Asia.* Denmark is the only Nordic country with no public supercomputer in the [Top500 list](#).

Advantages of a national HPC infrastructure

For many years the Danish Center for Scientific Computing (DCSC) model with regional facilities has had many benefits. However conditions have changed. For the future, a common national infrastructure for high-performance computing hardware has substantial advantages:

1. **Increased overall efficiency with reduced operational costs**

Larger facilities installed in other countries have proven to be very cost-effective, i.e a single larger installation significantly reduces operating and maintenance costs compared to many, smaller facilities. It is no accident that national HPC infrastructures are present in the vast majority of European countries, USA, China and Japan and many others.

2. **Sharing of resources among users**

A common national HPC infrastructure, with a single large, true HPC site, will allow a sharing of resources that has proven difficult with regional computing centers. The resulting bigger pool of users will guarantee the optimal utilization of available resources, minimizing inefficiency and waste.

3. **Big science**

Truly large facilities are the only option for the particularly computing intensive applications in academia and industry that are currently not run at all or run on foreign facilities by the Danish PRACE grant holders. Operating costs for such facilities, including cooling, electricity and staffing, are growing. The next generation of petaflops machines will be even more demanding in terms of running costs and too expensive for a single institution. *Future provisioning of such machines requires collaborative effort, funding and sharing.*

4. **Support of SMEs**

Private companies cannot interact easily with a fragmented regional installations, while a true national infrastructure will allow the industry to realize the full potential of e-science. A

¹ The USA, EU, China and Japan continue to invest huge sums on creating the necessary infrastructure to support these developments because of positive return on investment in terms of growth in the industrial and commercial sectors, and the effect of e-science on healthcare, transportation, renewable and clean energy and climate modeling.

single infrastructure, will give industry access to modern simulation and data processing without the need of very costly initial setup.

5. Skill development

Denmark's long-term competitiveness depends to a large extent on keeping up with the rapid evolution of scientific methods and technology. A National HPC facility will provide access to state-of-the-art technologies which would otherwise be too expensive to operate for a single institution and not only provide top researchers with a much needed scientific tool, but also contribute to the development of excellence of e-science skills much needed by companies.

6. Increased competitiveness for Danish research and industry

HPC in the Denmark is rapidly losing touch with the most advanced high-end supercomputers. In the latest [Top500 list](#) of supercomputer's sites, no single machine is present from the public Danish sector and only one from the Danish industry. The situation is very different for e.g. the other Nordic countries, which all have *at least* 3 public sites in the Top500 list in addition to the ones owned by the private sector. If action it is not taken to change the current trend, the competitiveness of Danish research, industry and the consequent benefits for society are at stake.

Recommendations to DelC

1. Funding of a Petaflop-scale HPC site, which can accommodate the needs of all existing and future HPC users in Denmark. DelC should support hardware and/or running expenses at a significant level.
2. Develop a sustainable and fair business model to operate the national HPC infrastructure, which grants access to the national HPC resources via regular peer-reviewed calls.
3. A board of HPC users and scientists should be in charge of the HPC site to guarantee *minimal management overheads*. This includes the procurement, installation and maintenance of the national machine and related e-infrastructure. The procurement of national infrastructure should be an open application process where the site capable of providing the best economical and support framework should be selected.
4. Establishment of dedicated e-science research and support groups at each university, incorporating the current DCSC centres, in charge of:
 - I. Supporting users in exploiting the local and national HPC infrastructure;
 - II. Assisting users in applying for resources at the national site or external resources such as, e.g PRACE sites;
 - III. Facilitating the use of the national infrastructure by the industry under conditions to be determined.

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