A Norwegian Research Infrastructure Resource Model

A methodology for declaring the costs and pricing the use of research infrastructure in externally funded projects at Universities and Colleges

Abbreviated version of a report from a national work group commissioned by

The Norwegian Association of Higher Education Institutions.

February 27th, 2014

Preface

The Norwegian Association of Higher Education Institutions (UHR) is the main cooperative body for Norwegian universities and colleges, whose purpose it is to contribute to the development of Norway as a knowledge-based nation of high international standard. UHR aims to be a central supplier of terms to the parliament and government and an important education and research policy player.

The Norwegian full cost model for research was developed in 2012 (the TDI model 2012). The TDI model specified the costs associated with research infrastructure and defined the term "Research Infrastructure Resource" (RIR). The TDI model indicated how to calculate a full cost based price for research infrastructure usage, which in turn prompted a discussion on the financial, legal and practical issues associated with full cost pricing RIRs. In 2013 UHR appointed a work group[1] to develop the RIR model further. The model should be sufficiently flexible and robust to cover the needs of all Norwegian universities and colleges. The resulting report was published in Norwegian, October 1st, 2013. UHR has recommended the RIR model as a methodology for declaring the costs and pricing the use of research infrastructure in externally funded projects.

This report is an abbreviated version of the report published in Norwegian. It is our hope that the proposed RIR model will contribute to the discussion on best practices in the area of research infrastructure operation and management.

Many have contributed generously to this work. We are indepted to the members of the work group and to all those who have generously shared their experience and expertice in the development and testing of the RIR model.

February 27th, 2014

The Norwegian Association of Higher Education Institutions (UHR)

For the full version in Norwegian: http://www.uhr.no/aktuelt_fra_uhr/leiestedsrapporten.

[1] Work group members: Lise T. Sagdahl, chairman (Norwegian University of Science and Tehnology), Kari Eidsheim (University of Bergen), Per Heitmann (University of Oslo), Simen F. Jørgensen (University of Oslo), Anita Vigstad (University of Bergen), Andreas S. Wangen (Norwegian University of Science and Tehnology)

Contents

Abstract

A "Research Infrastructure Resource" (RIR) is in this report defined as a laboratory or other common infrastructure for which the operating costs are presented separately and distributed proportionally between the projects and activities which employ the infrastructure.

The Research Infrastructure Resource Model (RIR model) presented in this document, provides a method to declare costs for use of research infrastructure based on the full costs generated by the activity. The model has been developed to ensure that state of the art laboratories and scientific equipment can be made available for research and education, and so that the price for use of a RIR can be calculated using a transparent and relatively simple method. Furthermore; the model should contribute to maximisation of the primary operation of the laboratories while keeping the transaction costs as low as possible.

The motivation for introducing RIRs is found in changes in the funding schemes and the focus on direct costs. The RIR model presented here has been developed in accordance with the guidelines from The Research Council of Norway.

The implementation of the RIR model requires that the institutions divide their research infrastructure into a number of clearly defined entities (RIRs). The scope of each RIR must be clearly defined, and one should strive to keep the number of RIRs low in order to minimize the need for administrative support.

The RIR model derives a price which equals cost per hour (or day/week/unit). The price is determined by the full costs of the RIR divide by the RIR's capacity.

$$\text{Price} = \frac{\text{Cost}}{\text{Capacity}}$$

The costs related to a Research Infrastructure Resource consist of four elements:

1. Space – rental and building related costs for research space such as laboratories and workshops
2. Scientific equipment – depreciation costs
3. Common operating consumables and service-/maintenance contracts, i.e. shared costs for all users
4. Technical support – personnel costs for the technical support staff needed to sustain the operational infrastructure.

The capacity of a RIR determines the denominator in the price fraction. To find the capacity, we have to answer the question: What is the number of hours the RIR's annual cost should be divided by to calculate the price per hour?

A RIR's capacity equals the total number of user hours a RIR is designated for in a normal operating phase.

The definition of capacity takes into account limiting factors such as service and maintenance time and the RIR's opening hours. The actual use of a RIR may deviate from the planned use, but subpar exploitation of a RIR due to low efficiency may not be used as a basis in the denominator of the price fraction allowing for a higher RIR price.

The design of the RIR model is based on the following simple principle:

> A fixed entry price which provides access to most of the RIR with an additional price for special equipment units and services.

In many cases, a fixed entry price may be applicable to the whole RIR. However; for particularly expensive equipment/components and/or technical services in connection with the performance of experiments *additional pricing* may be needed. In such cases, the entry price *plus* the additional price will apply.

The RIR activity must be documented, either by means of active logging or by way of contractual budget and deviation checks.

The suggested RIR model is flexible and may be adapted to various types of research infrastructures. This however, entails that the research community itself must take on a considerable responsibility when it comes to employing the model in its own organization. Necessary assessments need to be documented to show that the prices are indeed reasonable based on the full costs at a defined capacity.

All users of the RIR will incur the same cost independent of whether an invoice is submitted to the project or whether the service is augmented by the institution. No use is free, but the sources of funding may differ. The institutions may contribute to a flexible implementation of the RIR model by keeping the transaction costs related to activities that are internally funded to a minimum. Thus, as a starting point, only externally funded projects and external users will be charged for use of the RIR.

Note that while a methodology for determining costs could lead to better funding, the traditions for pricing varies considerably and the model will probably be met by some resistance in research fields where the prices determined by the RIR model are very high, and in fields where users have not been previously charged. Awareness of the costs/prices of research infrastructures will, however, provide a basis for discussions on strategy, prioritisation and funding. The main focus should be on the scientific goals and needs of the RIR. Externally funded research projects generally increase in scope, complexity and often entail cooperation across organizational boundaries and joint use of research infrastructure. (In Norway, large research infrastructures funded by the Norwegian Research Council and partner institutions are considered common). When universities and colleges cooperate with each other and with research institutes, hospitals, etc., a number of challenges arise regarding government subsidy regulations, VAT and market adaptations. Awareness of the costs of RIRs might help to draw attention to some of the legal and financial issues that have to be resolved in such partnerships.

A Norwegian Research Infrastructure Resource Model

A "Research Infrastructure Resource" (RIR) in this report is defined as a laboratory or other common infrastructure for which the operating costs are presented separately and distributed proportionally between the projects and activities which employ the infrastructure.

The primary goals related to developing a RIR model are:

- to safeguard research infrastructure availability
- to ensure sound operation, maintenance and development of high quality research infrastructures
- to contribute to maximising utilization of research infrastructures for primary operations, as well as handling gradual development of the activity in a new laboratory and expansion with new scientific instruments

In order to achieve these goals, the full investment and operating costs for the research infrastructure must be documented and used as a basis for calculating a price for use of the research infrastructure. This should be done in the simplest way possible in order to minimize administrative costs.

Changes in external funding regulations have been an important driver for developing the RIR model. The 2010 national initiative for the development of large research infrastructure entails a requirement for a concise overview of both the costs and activities which will constitute a useful basis for strategic discussions and priorities. The Research Council of Norway has also reorganized its support with regard to scientific equipment by contributing to the acquisition of such equipment only in so-called "National infrastructures", and expects to cover costs for the use of existing equipment in the institutions which carry out the research. The EU's impending framework programme for research, Horizon 2020, allows costs for use of large scale research infrastructure to be declared as direct costs with full reimbursement (not as indirect costs with a standard rate for partial reimbursement).[2] The support policy of both the Research Council of Norway and the EU therefore necessitate the development of a RIR model providing a price for use based on full costs.

The definition of a RIR indicates two core issues which need to be clarified:

- «*operating costs are presented*»
  It is necessary to define relevant cost elements for a RIR so that there will be no overlap between RIR costs and indirect costs.
- «*distributed proportionally between (…) projects and activities*»
  The costs must be distributed on a relevant cost unit such as hours/days/weeks, unit, sample, etc.

A RIR model will yield a price for use of RIR per hour/service. The price is calculated using the same criteria for all users.[3] Externally funded research projects making use of RIRs will enter costs as direct costs in the project accounts and the grant funded portion of the activity will receive a corresponding income. This will lead to a more correct charging of the costs accrued to the project while providing

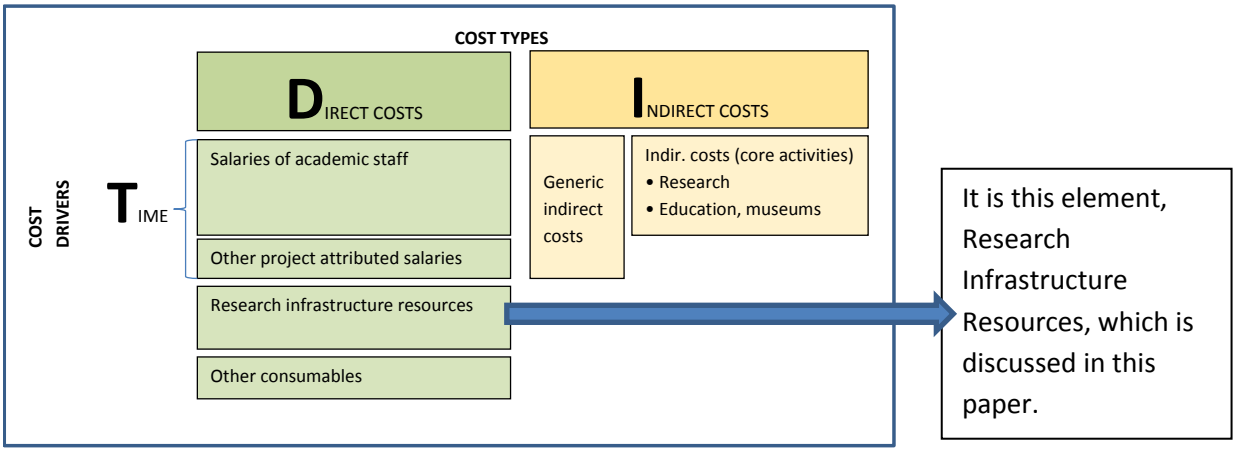
[2] The handling of RIRs which are not included in the concept «large infrastructure», remains to be clarified.
[3] Non-economic activities

institutions the opportunity for reimbursement of expenses for research infrastructure which previously did not elicit payments. Internal funds which are currently spent on funding the operation of the research infrastructure are freed for other purposes. Actual RIR costs which have not been included in the budget accounts constitute a hidden and often unquantified co-funding by the institutions in addition to the documented co-funding.

Note that for internally funded projects, it will *not* be necessary to invoice the projects for RIR services. The institution may freely cover such services and make the RIR available without cost to internal users. However; it will be necessary to obtain an overview of the sum total of all internally funded activity at the RIR so that the price which is employed for externally funded projects may be calculated on the basis of the *same criteria for all users*. It is important to promote awareness that the use of the RIR will have the same cost for all users independent of whether an invoice is submitted to the project or the service is covered by the institution. All usage generates a cost. There may be important management information in the detailed tracking of RIR services, but the institutions must assess for themselves what will be a suitable level of detail and the correct scope of internal invoicing.

The Norwegian full cost model for research was developed in 2012 (the TDI model 2012)[4] specified the elements in the RIR costs, but did not develop the RIR concept further and left pricing to the individual institution. An introductory work by the three principal Norwegian universities revealed considerable challenges. When this became clear The Association of Higher Education Institutions appointed a work group to develop a common price model – the Research Infrastructure Resource (RIR) model, sufficiently flexible to cover the needs of all the Norwegian universities and colleges.

Figure 1 The Norwegian full cost model (TDI)



A RIR may consist of anything from many larger research infrastructures to an individual unit of equipment. The institutions must themselves assess what is the appropriate number of RIRs per faculty/department/research community. The TDI model is flexible and may be adapted to the requirements of individual institutions and research communities. Before the model is presented in detail, we present the basic idea behind it.

[4] http://www.uhr.no/documents/TDI_NorwegianFullCostModelFinal.pdf

In order to calculate a price for a RIR, the following must be performed:

1) Delimitation of the RIR by clearly describing which laboratories/scientific equipment are included
2) Identification of the costs related to the RIR
3) Determination of the capacity of the RIR

The price for the use of a RIR may thus be calculated as:

$$\text{Price} = \frac{\text{Cost}}{\text{Capacity}}$$

The delimitation of the RIR must be set locally and in close collaboration with the research community. The more RIRs, the more demanding it will be to keep the price lists updated over time. The delimitation is discussed in chapter 1.

The numerator in the fraction, costs for each RIR, consists of space costs, depreciation costs related to the equipment, common operating consumables and personnel costs for the technical support staff which are linked to the RIR (the necessary technicians for the RIR to be available for use by researchers). The costs are described in chapter 2. Some of these costs are available from accounting reports. For other types of costs (space and technicians), it may be necessary to collect data from other sources. A succinct delimitation of the RIR is necessary to avoid costs being counted more than once or omitted.

The denominator in the fraction – capacity – is the unit the costs are distributed by. In this report, we employ hours as the cost unit and hence we refer to an hourly price.[5] How to determine the capacity is discussed in chapter 3.

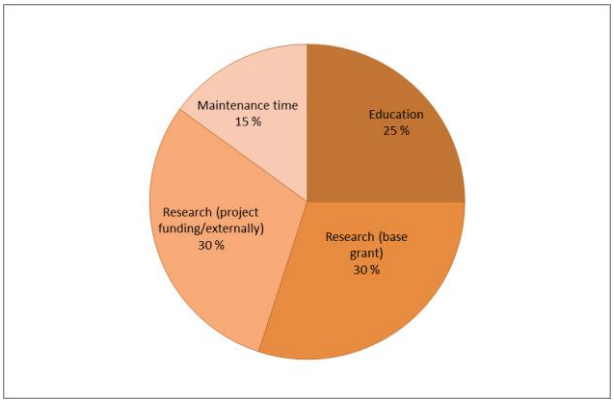
The RIR model is presented in its entirety in chapter 4. We discuss the documentation of the use of RIR services in chapter 5. In chapter 6 we discuss some practical issues related to the RIR model.

Chapter 7 deals with other important challenges and rules related to cooperation and joint use of research infrastructures.

The activity related to a research infrastructure may be distributed in several categories as illustrated in figure 2 below. In the development of the RIR model, we take both educational and research related activity into account and also time for necessary maintenance ("maintenance time"). The scope and distribution between activities will vary from infrastructure to infrastructure and may change over time.

[5] In most cases, hours will be used as the cost unit, but in some cases, there will be a requirement for using other cost units, for example price per service, analysis or another unit. Only knowledge of local practice may uncover the requirements for alternative cost units, therefore, it is essential to include the research communities in the establishment of RIRs.

Figure 2 Illustration of RIR activities (the scale is only included by way of example).



1 Delimitation of a RIR

The RIR model we developed needs to be flexible and adaptable to the individual institution's and research community's requirements: capable of defining anything from a larger collection of research infrastructures to a single unit of equipment. The guiding principle for delimitating individual RIRs will be to keep the degree of detail on an appropriate level. Several laboratories within the same area of expertise and relatively similar laboratories within a department or research group may be included in a given RIR keeping the numbers of RIRs as low as possible. While a detailed price list for individual services may seem desirable and equitable, a detailed approach will lead to considerable additional work calculating and maintaining price lists.

The RIR model takes into account that more expensive or more specialized equipment needs to be priced higher than the average price for a RIR. The model depicts how these units may have additional pricing. Alternatively, such units may be defined as a separate RIR (see chapter 4). An average assessment for large RIRs should be employed for pricing where this suffices. It may be advisable to start with a simple large RIR and simulate price changes resulting from segregating more costly equipment for added pricing or by creating more and smaller RIRs. If the operating costs or the capacity of a unit's equipment make the hourly price for the unit deviate considerably from the average price, there are two main arguments to introduce an additional price or remove the unit and create a separate RIR. These are as follows:

- Fair distribution of the costs in cases where the entry price is considerably elevated by an expensive piece of equipment.
- Economic activity/contract research: If an average price results in an unreasonably low price for the use of a unit of equipment this may lead to indirect state-aid and VAT evasion.

The institutions in charge of the operations must decide on the appropriate level of detail when it comes to the number of RIRs and the needs for additional prices.

2 RIR costs

In the introduction, we referred to the TDI model and cited briefly the four cost elements which constitute a RIR:

1. Laboratories/workshops – space costs
2. Equipment / machines / ships – costs related to depreciation of scientific equipment
3. Common operating consumables like chemicals, materials, and maintenance contracts etc.
4. Technical support staff – personnel costs

A more detailed review of the four cost elements follows.

2.1 Laboratories / workshops

In order to determine the space costs for a RIR we include rooms that are categorized as laboratories/research space and workshops, and which are used for research or for a combination of research and education. Rooms used solely for education purposes are not included in a RIR. Institutions with a space/room database will normally have a good understanding of the use or purpose of various rooms, and the databases can be used as a starting point.

When calculating the total space costs for a RIR, both operating costs and capitalised costs are included and the calculation is based on the gross number of square meters per room.

2.2 Equipment / machines / ships

Scientific equipment is identified by means of specific accounts (numerations) in the chart of accounts. Relevant specific accounts are those which apply to scientific equipment as well as research vessels. Please note that only depreciation is charged to these accounts. Costs related to the acquisition are activated in the accounts and constitute no relevant cost.

The specifications of depreciation costs use the total survey of each institution as its starting point. This entails two issues:

a) All depreciation costs linked to the institution's research infrastructure must be identified. Costs related to laboratories used exclusively for educational purposes, must not be included in the RIR.
b) Depreciation costs should then be distributed over a number of defined RIRs, see chapter 1. This distribution may be difficult to identify precisely because the costs may be entered in a central account or in another manner which will make the identification relative to each individual RIR difficult. Such costs should be distributed based on a local review of the equipment in the fixed assets registry. The distribution method must be documented and be available for audits.

2.3 Common operating consumables

Common operating consumables for a research infrastructure include chemicals, materials, and maintenance contracts etc. which are normally shared by users of the RIR. Costs that are attributed to specific projects or users are not included. The challenge is the same as for depreciation related to scientific equipment: Common operating factors for research infrastructure must be identified and distributed over a number of defined RIRs. Local knowledge of operations is important to sort out

costs which are related to educational activities or are in other ways not for common use by all users of the RIR.[6]

2.4 Technical support staff

Technical support includes personnel costs for technical support staff necessary for the RIR to be available for use by the scientists. Relevant costs include wages, social and indirect costs for a "workplace".[7]

In the university and college sector, the technical support staffs have a number of tasks related to education and research. In order to find an hourly price for the use of the RIR which reflect *essential personnel costs*, we choose to include *only the man-hours necessary to ensure that the RIR is available for use by the researchers*. In this manner, we avoid a situation in which the hourly price is unreasonably high for researchers who carry out research activities without the assistance of support personnel. In case of the need for assistance beyond what is included in the hourly rate, for activities such as preparations, execution and post work, the technical support staff may be hired at a price per hour which covers wages and indirect costs, see chapter 4.

The number of staff necessary for the RIR to be ready for use will vary greatly between the various RIRs dependent on which tasks the researchers carry out themselves and which are included in the maintenance contracts. For advanced laboratories which require that technical personnel are present, it is reasonable to include these services in the hourly price of the RIR. One technician may divide his/her time between several RIRs. An assessment of the time spent and distribution of the costs must be made for each research facility and RIR. The results must be documented.

In the design of the RIR, only technician man-hours directly associated with the project may be included when allocating costs in projects with university contributions. Please note that administrative man-hours are included in the indirect costs in the TDI model.

3 RIR capacity

Some infrastructures are in use day and night throughout most of the year, whereas others are seldom used. Some research infrastructures have many qualified users and others only a few. Internationally, one often distinguishes between research infrastructures organized as:

- "user facilities" where the organisation have a high activity/exploitation rate as its goal. These infrastructures often contain a broad spectrum of scientific equipment and offer services and training for a broader group of scientists.
- "research facilities" where the activity is directed at a narrower area of expertise with few users. This is often infrastructure dedicated to a group of researchers or projects which re-

[6] As an example: materials and equipment which are only used in one particular project and which therefore are not covered by the price for the RIR. This may also apply to buildings of models and fixtures for the execution of laboratory tests.

[7] Here indirect costs for technical staff are included in RIR costs as defined by the Norwegian full cost model (TDI model). An alternative approach better adapted to EU's rules, would be to include the indirect costs for technical staff in the calculation of indirect cost for research staff, and not in the RIR costs.

quire special equipment or conditions. The number of user hours will normally be lower than for “user facilities” resulting in a lower exploitation rate.

Large research infrastructures may contain elements of both categories. Normally, an infrastructure will consist of a collection of scientific equipment with varying degrees of exploitation. This *variation* in the exploitation rate is a considerable challenge when trying to allocate the operating costs on the projects using the infrastructure. It is administratively demanding to find prices for each individual equipment unit based on actual use. Therefore, we employ a methodology to find the average prices for several equipment units.

The capacity (the denominator in the price fraction) is the number of hours the cost is to be distributed over. For an individual equipment unit, the capacity may be defined as follows: *An equipment unit’s capacity equals the number of user hours the equipment unit has been designated for in a normal operating phase.*

Note that the use of “user hours” reflects the most common way to price laboratory services. Alternatively, the price can be calculated per service or analysis (for instance weekly rent of a cage in an animal facility). By designating the scope of an activity, the capacity becomes a target figure for user hours for which the costs may be equitably distributed. Because we are talking about a planned use for which the equipment unit has been designated for, instead of the actual use (which may be recorded), the capacity may be higher than the number of hours for which the unit has actually been used during a given year. Later in this chapter, we will discuss the challenges related to unused/”idle” time and changes in activity over time.

When a RIR consists of more than one equipment unit (instrument/working station/activity), several users may use the RIR simultaneously. In order to determine the capacity for a RIR with *several* units of equipment, we must take into account the average number of user hours per equipment unit and multiply by the number of simultaneous activities at the RIR. Note that this number includes all activities, including experiments that do not require personnel to be present.

A RIR’s capacity equals the number of user hours a RIR is generally *designated for* in a normal operating phase.

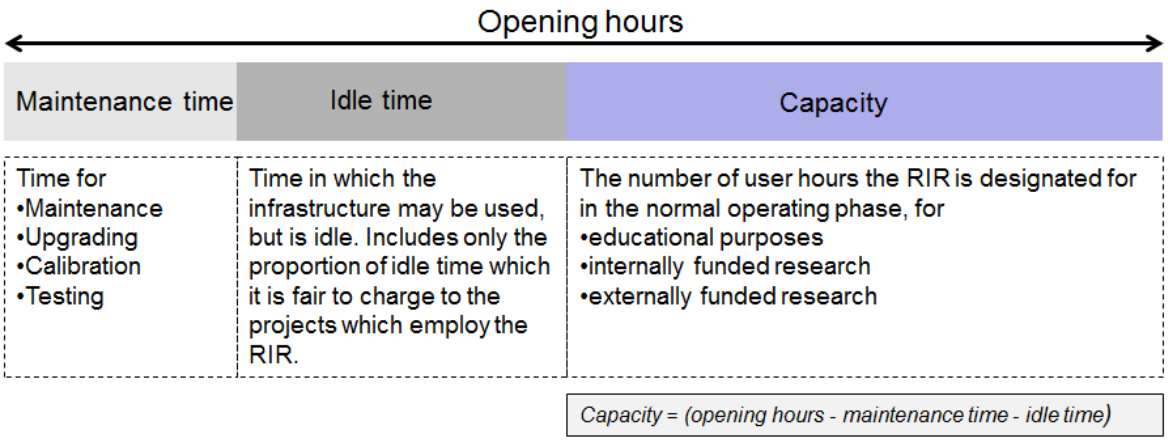
It is important to note that under normal operation conditions, there will be a relationship between the cost (the numerator in the price fraction) and the capacity. An increase of the capacity may for instance require more technicians or more space. For RIRs with lower exploitation and/or great variation in use over time, there is a challenge related to determining an average number of user hours without going deeper into assessments related to unused (idle) time. In the following, we describe a robust method for determining capacity which links capacity to equipment units.

A RIR’s capacity may be determined as follows:

1. For every piece of equipment or collection of equipment: Use the number of potential user hours given by the opening hours for the RIR; deduct time for maintenance (percentage of the opening hours), and the share of unused time (idle time) which is reasonable to charge the projects which use the infrastructure (percentage of the opening hours).

2. Find out how many equipment units or simultaneous users the RIR has. This may include counting the work stations and/or larger equipment units. Add up the numbers which may be used simultaneously in order that all users obtain acceptable working conditions.
3. The RIR's capacity is found by taking the adjusted opening hours (section 1) multiplied by the number of equipment units or simultaneous users (section 2). In cases where the equipment units have different capacities (i.e. different opening hours, time for maintenance or idle time), the average capacity for the equipment units is used in the calculation.

Figure 3 Capacity



In the following, we define some concepts which are used in determining the capacity for a RIR and present an example.

3.1 Opening hours

The opening hours for a research infrastructure equals the number of hours an infrastructure is open per day/week/month/year. The opening hours will depend on several factors such that the requirements to have technical personnel present (number of shifts), operating conditions (use of energy), various Health Safety and Environment considerations which limit the opportunities to work alone. The opening hours will therefore vary between the various RIRs and over time if the activity increases or diminishes.

3.2 Maintenance

For all RIRs, some of the time will be spent on necessary maintenance, upgrading (including calibration and testing). This is deemed "maintenance time" in this paper. Maintenance precludes other activities in the timespan it is carried out. This means that maintenance entails a cost which should be distributed over research and educational activities which employ the infrastructure. This in turn means that these costs are distributed equally to all hours in the projects. Maintenance time (which is included in the opening hours) is therefore deducted when the capacity (the denominator in the price fraction) is determined for the RIR.

3.3 Idle time

Unused or idle time is time when the infrastructure is available and may have been used if there had been a demand from interested and qualified users (projects) or if the infrastructure had been operated more efficiently. This is crucial and problematic in the development of a RIR model.

The question becomes: Who pays the costs of the idle time? Should these costs be covered by the owner of the infrastructure or by the projects/activities which employ the infrastructure? Or put differently: Should idle time be included in the RIR's capacity (resulting in a lower price), or should the idle time be kept out (resulting in a higher price)?

Before we answer these questions, it is imperative to consider that many research infrastructures are employed for very specific purposes and used for far fewer hours than normal working hours allow. In order to ensure sustainable operations for these highly specialized infrastructures, operating costs should be covered by the projects which use them, regardless of whether the projects are funded internally or externally. This understanding is confirmed by the guidelines from the Research Council of Norway on "National infrastructure" and the EU's proposed guidelines to define the use of infrastructure as direct costs.

The host institutions are responsible for stimulating demand and maximizing resource exploitation. In addition, good planning and execution of experimental activity will reduce idle time. However; the institution which owns and operates the infrastructure has an opportunity – and perhaps even an obligation – to take on part of the risk and cost for idle time. The assessments regarding the coverage of costs and idle time will therefore be based on knowledge of the individual institution's infrastructure characteristics and use. Below are recommendations which may secure a reasonably equitable practice for handling idle time and determining capacity, and hence prices.

In order to determine both maintenance time and idle time, all use of RIRs should be registered, either with a simple log-in and log-out or other similar type registration. Alternatively, the activities should be estimated, for instance by assessing the number of users per RIR and the number of hours per user. We comment on this issue more in depth in chapter 4.

The assessment necessary to determine the number of greater equipment units which may be comparable or equivalent and thus be priced similarly, requires local knowledge of the daily activity related to the RIR. Smaller equipment units may be converted to larger units, for example two - three small units may be calculated as one larger unit. Alternatively, smaller equipment which is seldom used for an extended period of time may be counted as part of other larger units.[8] In both cases, the objective is to find comparable (equivalent) units so that calculating an average hourly price will be reasonable.[9] In some RIRs with basic equipment in areas such as chemistry, biology and biotechnology, the number of work places/stations at the laboratory desks or fume hoods should be counted as equivalent units (simultaneous activities).

[8] Please note that the approaches result in different prices because the capacity (the numerator in the fraction for price) is changed when the number of larger equipment units is changed.

[9] Not all laboratory/RIR activity may be specified on an hourly basis. In some cases, there may be a need to define a cost unit other than hourly. Knowledge of local practices may uncover the requirement for alternative cost units. Therefore, it is also essential to include the research community in the establishment of RIRs.

The example below shows a research infrastructure of the type "research facility" which is not in continuous use during the openings hours. The scope of maintenance time and idle time is based on observation of the activity or registration of user hours.

Example: Stipulation of a RIR's capacity

Imagine a RIR with

- 3 large instruments (with the appurtenant preparation equipment and other auxiliary equipment)
- Opening hours between 8 am and 6 pm on weekdays (10 h per day x 5 d per week x 52 weeks per year = 2 600 h per year)
- Maintenance time per instrument on average: 20% of the opening hours (520 h)
- Idle time per instrument on average: 30% of the opening hours (calculated per year, including holidays and days off) (780 h)

The capacity will be: 3 x (2 600-520-780) h = 3 900 h (total for 3 equipment units).

Total RIR costs to be distributed over 3 900 hours.

An alternative method to find the capacity for the simplest case where a RIR has a high rate of exploitation and relatively similar equipment units is to find the expected number of total users at the RIR and multiply this figure by the planned number of hours per user per year.[10] The challenge is to estimate the average number of hours per user since the scope of use often varies significantly between various users depending on which equipment units are employed. The example below shows a calculation of capacity by means of users and hours per user for RIRs of the standard type of laboratories used by biology, chemistry and bio technology. The method also requires that an assessment is made of the number of users which may work simultaneously at the RIR.

Example: Capacity determined on the basis of the number of researchers and hours per researcher (Please note that this method may only be used for the simplest RIRs with high rate of exploitation)

- Number of users, full time equivalents (FTEs) of the lab: 20
- Hours per FTE: 1 628
- Hours per user: average fraction of FTE: 35% (560 hours per user)

The capacity will be: 20 x 1 628 h x 35% = 11 396 h

Total RIR costs to be distributed over 11 396 hours.

[10] It is unclear whether this procedure will satisfy EU rules in Horizon 2020.

3.4 Challenges related to the determination of RIR capacity

The greatest challenge related to the implementation of the RIR model is handling idle time in determining the RIR's capacity. This is a well-known issue to all who plan and optimize the operation of research infrastructure. A commercial enterprise will aim to make a profit, whereas the institutions in the HEI sector aim to cover costs. In both cases idle time must be dealt with in a best practices and acceptable manner to promote efficient exploitation of the resources.

The capacity may reflect a strategically chosen, i.e. a desired number of user hours, or an anticipated number of user hours based on realistic experience and projections in order to procure projects.

The prices for a RIR service will depend greatly on the capacity. The determination of capacity will therefore entail an assessment of conflicting considerations. If you define a high capacity, the results are lower prices and therefore less external contributions for necessary maintenance and further development of the infrastructure. However; with greater volumes and more efficient exploitation of the resources, low prices may nevertheless add up to an acceptable level of external funding. On the other hand, a very low capacity may result in high prices which no-one in the market is willing to pay and thus reduce the exploitation of the infrastructure even further. In both cases, the RIR provider will be left with a risk of diminished external contributions for maintenance and further development.

RIR prices may vary considerably even for comparable activities. If the RIR prices which the institutions suggest are perceived as unreasonable compared to prices for similar services elsewhere, this may lead funders and partners to question the basis of the price calculations. In such cases, the assessment must be presented and explained. We consider it necessary to introduce some guidelines for the determination of capacity. If the RIR model is to work, it must result in *sensible* prices which will withstand checks and comparisons. The prices must therefore in general be accepted by the contributors and the clients without extra requirements for documentation of costs and capacity in each individual case.

We return to the question of *how much idle time may reasonably be charged to the projects employing the infrastructure.* Or: How much idle time is equitable for the institution to cover in cases where the exploitation is lower than what is considered standard operating practices of the RIR?

First and foremost we discuss what a reasonable lower limit of capacity is for laboratories were the exploitation is low compared to a theoretically feasible exploitation. Afterwards, we will comment on the opposite extreme.

Low degree of exploitation

Some factors influencing the assessment of what is a proper rate of exploitation at a research infrastructure are:

1. *Distinctive character:* Why does the research infrastructure exist? What goes on in the laboratory/workshop?
2. *Demand:* How many users are qualified and/or interested in using the research infrastructure? How many hours will the users employ the infrastructure?
3. *Efficiency:* How efficiently is the research infrastructure operated (planning and execution of activity)?

4. *Phase of life:* Is the research infrastructure under construction/development, in stable operation, or ready to be phased–out?
5. *Opening hours:* How many hours per day/week is the research infrastructure available for the users (average, annual basis)?

Item 1 regarding distinctive character provides a basis to comment on the RIR's strategic importance and role, which again is important for the institution's desire to fund any idle time.

The demand (item 2) will provide a basis to assess anticipated activity. As we mentioned in the introduction to this chapter, some of the RIRs are directed toward a narrow field of expertise with few users. This is often infrastructure dedicated to a group of researchers or projects which require special equipment or conditions. Low exploitation may therefore be justified in many cases.

The efficiency (item 3) affects idle time directly. If the activity is planned and carried out as efficiently as possible, it is reasonable that idle time between activities/experiments is charged to the projects.

Item 4, phase of life is important to assess how much idle time is equitable to charge the projects in various phases. It is expected that those in charge of a RIR will always promote a sensible exploitation of the infrastructure. However; in a construction phase, the exploitation will normally be lower than in the operating phase. The institution has to assess how much idle time it is willing to fund in the construction phase. At the end of the life cycle, when a RIR is being phased-out, it is reasonable that the institution funds a greater proportion of the idle time than during a normal operational phase. This is important in order to promote necessary change and favourable exploitation of the available laboratories/space.

Opening hours (item 5) often depend on the requirement for technical support staff. For RIRs in which technical support staff are necessary and with no shift work system, a normal man-labour year of 1628 hours (the TDI model 2012), will be a reasonable starting point in order to determine the capacity. Maintenance time and idle time which is proper to charge the projects is deducted from this figure.

Thus, in order to find reasonable prices for a RIR, the institution must know the total operating costs and assess the number of user hours each RIR should be designated for. If the actual exploitation is lower than the capacity, the institution will carry the costs of the idle time. The institution will also have to decide how much idle time it is willing to accept without discontinuing the infrastructure.

A useful exercise for the owner of the RIR may be to put oneself in the external contributor's place and consider whether the capacity is reasonable and sensible for those who contribute to funding of the activities.

High degree of exploitation

For laboratories which have a high degree of exploitation (i.e. a high number of users and user hours), the determination of capacity is reasonably simple. In such cases, one uses the anticipated or planned activity related to research and education as a basis: This means using the number of user hours including the necessary down time between experiments (with maintenance time excluded). The capacity is set *equal to* anticipated activity. In cases of growth, the capacity should be set high

enough that the capacity is never *lower* than the actual number of user hours that will be logged in a given year.

4 Model design and price calculations

When a RIR has been delimited, and the capacity full costs have been determined, we are able to calculate an hourly price for the RIR. In the simplest form, an hourly entry price provides full access and use of all the equipment units within the RIR.

In many cases a fixed entry price may be applicable for the whole RIR. However, additional pricing may be needed in two cases:

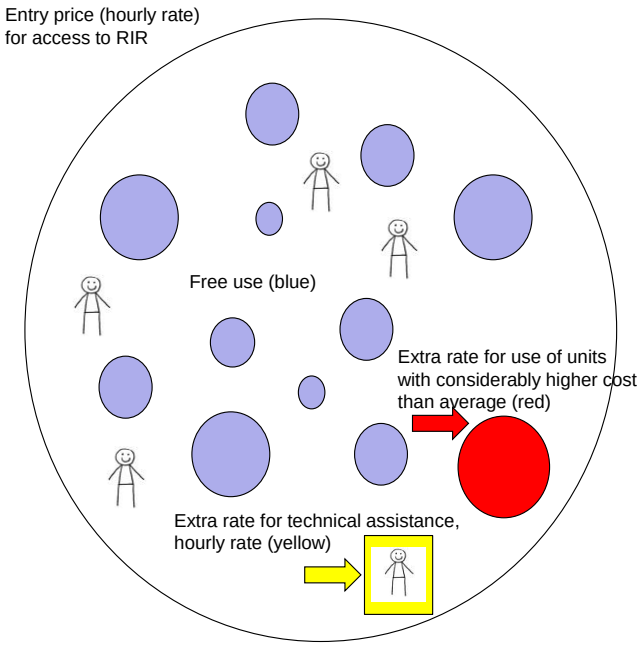
a) Firstly; there will occasionally be a requirement for assistance from technicians in the actual execution of research activities in the laboratory. Such assistance is not included in the entry price and should be *priced by the hour* separately.
b) Secondly; there may be individual equipment units within the RIR which have considerably higher costs than the average of the other units. In such cases, it should be reasonable to calculate an *additional price* for the use of these units.

The model is analogous to the pricing for an amusement park:

Main principle: Fixed entry price which provides access to most of the RIR, additional price only for special equipment units and services.

Figure 4 illustrates a RIR in which the entry price provides full access to most equipment units (blue circles) with the exception of one unit (red circle) which has an additional price. The entry price includes the costs related to the technical support staff ( ) which are necessary to make the equipment units available for the scientists. In case extra technical assistance (yellow square) is needed, an additional price applies. Please note that the equipment units may be in use simultaneously.

Figure 4 Illustration of a Research Infrastructure Resource (RIR)



The number of equipment units within a RIR and the number of units included in the entry price may differ for various RIRs. For some RIRs it will be straight forward to include all equipment units in the entry price (no additional price for equipment units). Other RIRs may have several equipment units which require a unit specific additional price. The alternative to having additional prices is to define these equipment units (red circles) as separate RIRs.

Calculating the average entry price is based on the assumption that the capacity for the "red" units does not differ significantly from the average capacity of the "blue" units. *Significant* variations in capacity will in most cases require that some equipment units are treated as separate RIRs.

4.1 Calculation of entry price

The general concept is that all users should pay the entry price, and that some users must pay an additional price. A proportion of the costs related to equipment with an additional price are therefore included in the entry price so the price model is equitable for all users. The additional price is intended to cover *extra costs* beyond those which are included in the entry price for all users.

The entry price is therefore based on the total RIR costs which may be associated with the included equipment units[11], as well as a part of the RIR costs which may be attributed the equipment units which have an additional price. This entails that:

- All space costs for the RIR must be included in the entry price.
- All wage costs for technical support staff necessary for the RIR to be available for use by the scientists, must be included in the entry price.
- In addition, depreciation and operating costs for all equipment units are included. For units that will have an additional price, we include in the entry price only the depreciation and operating costs which equal the average depreciation and operating costs for all "blue" units.[12] The remaining depreciation and operating costs are included in the additional price, see below.

Entry price per hour =

$$\frac{\text{included RIR costs}}{\text{number of large units x average capacity}}$$

The number of large units in the formula is determined by defining the number of equivalent equipment units in the RIR (simultaneous activities, blue and red circles; figure 4). Here, necessary assessments must be made for the individual RIR.

[11] See chapter 2 for a detailed description of costs.

[12] An equipment unit may have a low depreciation cost and high operating costs or vice versa. It is the total of these costs compared to the average for the included ("blue") units which is important when the additional price is stipulated.

4.2 Additional price for technical assistance

Technical assistance or operators (yellow square in figure 4) to assist in *the execution* of research activity (i.e. technical assistance needed *in addition to* that which has been included in the entry price for the RIR and/or the additional price for the red units) should *always* be priced separately – per hour. The actual wage costs, including social costs as well as the indirect costs for space and services, constitute the numerator of a fraction when calculating the hourly rate, whereas the denominator is 1628 hours (the TDI model 2012).

Technician price per hour =

$$\frac{\text{wage costs (incl. social costs) + indirect costs}}{1\,628}$$

Note that the indirect costs for technical staff are included in RIR costs as defined by the Norwegian full cost model (TDI model). An alternative approach better adapted to EU's rules, would be to include the indirect costs for technical staff in the calculation of indirect cost for research staff, and not in the RIR costs.

4.3 Additional price for particularly expensive equipment

The additional price is intended to cover extra costs per hour for special units which have significantly higher depreciations or/and operating costs than the other "blue" units (figure 4). As described above, part of the costs for expensive equipment ("red" unit) are included in the entry price together with all of the depreciations and operating costs for the "blue" units. The remaining costs for the "red" unit are included in the price fraction for the "red" unit. The denominator is the capacity of the "red" unit.

Additional price per hour =

$$\frac{\text{remaining depreciations + remaining operating costs}}{\text{capacity}}$$

None of the costs in the numerator for the additional price should be included in the entry price. Please note that all space costs and costs related to technical assistance should only be included in the entry price in order to keep the model simple and avoid unnecessary administrative effort. This is an approach which has to be considered if some "red" units require considerably more space than other units, or if they require substantially more of the laboratory technicians' time than other units. A more detailed division of costs for space and staff per unit is administratively demanding and should be avoided. Please note that a RIR may be split into two or more RIRs if an assessment of the average cost and capacity for a given RIR produces unreasonable effects on the entry price and/or the additional prices.

5 Documentation for use of the RIR

This chapter focuses on charging the projects for the use of RIRs. The RIR model assumes that it is possible to find and document the number of user hours per project. Ideally, all activities should be registered by some sort of time recording system (chapter 5.1) but such systems have an administrative cost which may not be justifiable for all RIRs. We will therefore suggest an alternative procedure to estimate the number of user hours per project without a time recording system (chapter 5.2).

5.1 With registration

Time recording may be performed either by means of simple logs/time sheets or with more advanced electronic booking systems. The costs related to RIR services may then be charged to the projects based on the *registered user* hours.

The simple recording systems assume that an individual collects information from logs/time sheets and determines the total number of hours per project. Many RIRs with externally financed research activities have already introduced routines and systems for such recording.

There are a number of computer systems on the market for reservation and logging hours. However; many of them are customized to suit numerous requirements related to the operation of laboratories in a specific fields of research (for example biotechnology or nanotechnology). Thus it is a challenge to find good generic systems which are suited to all types of RIRs.

All time recording systems are more or less based on trust. In order to minimize error, *all* users of a given RIR should be subjected to the *same* requirements for time recording, irrespective of the funding source. It may however only be feasible to register activity for externally funded projects, but such practice may lead to loss of income if users neglect or forget to record time on applicable projects. Each individual institution/research community must assess what the appropriate and adequate routines should be with their project portfolio.[13]

In Horizon 2020, time recording will most likely be a *requirement* for RIR costs to be approved as direct costs. The preliminary guidelines state the following about RIR costs (EU 2013):

> *"For the other costs of the infrastructure (read: Not personnel costs), the time actually used for the project must be traced through a reliable time recording mechanism (timesheets, logbooks, counters, etc.).*
>
> *In case that a cost can be directly measured to the infrastructure but not directly to the project, an acceptable alternative to measurement of the time actually used for the project would be measurement of the units of actual usage for the project, supported by accurate technical specifications. Project time must correspond to the actual hours/days/months of use of the infrastructure for the project…"*

5.2 Without registration

The nature of some research infrastructures is such that time recording will require an unreasonable administrative effort. Typical examples are laboratories with basic equipment for chemistry, biology, biotechnology and similar, where bench space or fume hoods are the equivalent equipment units in

[13] Registration of all activity will provide a better basis on which to determine and argue the *capacity*, but if the capacity is estimated on the basis of anticipated opening hours, idle time and maintenance time, this may suffice for all external contributors.

the RIR model. Other examples are laboratories for sample preparation, heat treatment and similar where the scientists often go in and out for short periods of time as needed. Typically, it is the *experiments* which occupy the bench space and fume hoods, whereas the scientists walk to and from and keep several experiments going simultaneously. Attempts at detailed registration of such activity will be challenging and difficult to justify on the basis of a cost/benefit assessment.

An alternative way to allocate user hours to projects employing the RIR is to distribute the RIR's capacity between the projects. This may be done by *estimating* the proportion of working hours the individual scientist requires access to the RIR.[14] *The number of user hours charged to the project per researcher will equal the proportion of working hours access to the RIR is needed, multiplied by the total number of man-hours for the researcher in the project.*[15]

The scope is agreed upon at the contract stage of the project and is quality assured during the project.

Example: A project with 5 PhD students using a RIR about 50 percent of working hours, will be charged for 4 070 user hours per year (5 x 50 % x 1 628 hours (TDI model 2012)).

This is an indirect method to find the number of RIR hours per project. We believe that this method will be acceptable for the Research Council of Norway as long as the institution is able to document the RIR's capacity (and thus the hourly rate).

6 A few practical issues related to the RIR model

6.1 Practical handling of the charge for the use of a RIR

Having examined how to find the number of hours per project with or without time recording, in this chapter we will proceed to consider some of the practical issues in various types of projects.

Internally funded use

In the RIR model, the costs related to the operation of an RIR have been distributed equally between all user hours. This means that even internally funded use will have an actual cost which equals the hourly price. However, it is not necessary to have a comprehensive system for internal invoicing which may produce unwanted transaction costs. The HEI institutions themselves will need to develop cost efficient routines for handling internally financed activity (see also chapter 2).

Projects funded in part by external funds

For projects that are partly funded by external funds, it is both correct and appropriate that the RIR provider charges the projects for all use. This will mean using the formulae: *Hours used multiplied by the hourly rate for the RIR/equipment unit.* The distribution of costs between the parties is regulated by the contract. It is important that the full costs for the use of a RIR (rate x hours) is made transpar-

[14] We envsision that scientist will require the RIR full time during some periods, whereas, more time will be spent on analyses, in-depth studies and publication in other periods. The distribution will depend on the characteristics of the area of expertise and the project. Please note that when the capacity for the RIR is stipulated, local knowledge of the use must be sought.

[15] If the technical staff related to the project employes the RIR, hours are counted in the same manner as for the scientists.

ent even in the instances where it is agreed that the institution will cover a portion of these costs as its own contribution. Such own contribution should not be hidden in the form of free access to the RIR or with discounts, but be contractual so that it is clear which part of the full costs is to be covered by the institution and which part is to be covered by external parties.[16]

Economic activities

For economic activities, separate prices apply, see chapter 7.1. RIRs which are employed for economic activity should therefore have *two pricelists* including both the entry price as well as the additional prices. The buyer of RIR services should also cover all costs and no self-financing by the HEI institution is allowed.

6.2 Fixed agreements

For all projects, and for use of the RIR both with and without registration, a total price may be agreed upon based on the hourly rate multiplied by the anticipated number of hours per project. The number of hours will be based on prognoses and previous experience. For research fellows on externally funded projects, it may be expedient to agree to such prices per year for the whole of the research fellowship period. The project manager may, at the point of application, agree upon a total price with the RIR provider. The project will be invoiced in accordance with the agreement. In cases where the gap between the actual activity and the agreed number of hours is considerable, adjustment to the total price should be assessed.

The use of fixed agreements, also called fixed prices, is convenient in order to reduce the number of invoices. Such agreements may make it simpler to budget the costs related to the RIR in project applications, and to plan the activity in the RIR.

6.3 Fluctuations in price

The RIR price calculated in chapter 4 is sensitive to changes in both RIR costs and capacity.

- Big investments in an RIR may cause significant price jumps from one year to the next. Similarly, equipment, which reaches the end of its depreciation life cycle, will cause a reduction in price. The need for maintenance contracts for new advanced equipment may also affect the price considerably.
- The capacity for the RIR is determined annually. The supply of projects and the need for RIRs varies over time and this may cause considerable fluctuations in activity from one year to the next. If the *actual number of hours* a given RIR is used in a year should *exceed* the predetermined capacity, the capacity must be adjusted at the next price calculation and this will in turn affect the price of the RIR.

Large fluctuations in price from one year to the next due to variations in the RIR costs and/or capacity will be a challenge. Reasonably stable prices over time will be an advantage both for the RIR provider, users and funders. In Norway, the prices for public services provided by the municipalities are calculated as an average for a 3-5 year period based on a comprehensive cost principle. A similar approach may be used for RIRs to avoid *large price fluctuations*.

[16] We want to avoid a situation in which the participants in a project participate on different terms: The same hourly price should apply to all.

Budgeted costs as basis for prices

The RIR model uses the costs entered in the accounts as its starting point (chapter 3.2). In order to calculate an average price over several years as described above, a combination of figures from the accounts and budgeted costs can be used (i.e. looking both backwards and forwards). When establishing a large research infrastructure, long-term budgets with plans for expanding activity (increased capacity) are prepared and may act as documentation of the RIR price calculated as an average over several years. When employing *future* costs as a basis for the pricing, proper documentation of costs such as investment decisions, maintenance contracts, staff changes, etc. will be required for audits.

7 Other challenges related to the RIR model

In this last chapter, we will explore the following challenges:

- Research as "economic activity" (contract research on behalf of an undertaking)
- Potential negative effects on activity
- Potential barriers for joint use

Some challenges are common in Europe and some might be specific to Norway due to our rules and regulations. For a more in depth discussion of these challenges, we refer to the Norwegian version of this report.

7.1 Research as "economic activity"

The predominant part of the research carried out in the HEI institutions, is "non-economic" activity, such as independent or collaborative research for more knowledge and better understanding. The RIR model presented in this document has been developed mainly for non-economic activity funded partly or fully by external contributors.

There are situations when a university or college abandon its primary non-economic service and engages in economic activities such as offering access to unused infrastructure capacity, supplying services to business undertakings or performing contract research. Such activities should be performed on *normal market conditions* and public funding of economic activities will generally entail State aid. In Norway, economic activity is also subject to VAT.

In order to comply with the state aid rules of the EEA Agreement, the accounts must be separated between the economic and the non-economic activities and there must be no cross-subsidization between the two parts.[17] The following safeguards prevent such spill-over: The full cost of the service provided as well as the price paid by the final users must be sufficiently transparent, so that the aid received can be measured and monitored.

In cases where investments in a research infrastructure have been funded by public grants or other public sources, such as national research councils, European framework programs, or special gov-

[17] In the EEA agreement's rules relating to public support under the heading «Public funded infrastructure", it is made clear that no selective economic advantage can be given to individual enterprises in the price the users must pay for using the the infrastructure. The price has to be calculated on the basis of the same criteria for all users, and the price covers all costs related to the establishment and operation of the infrastructure which is offered.

ernment grants given by the ministries, the price for using the RIR will be higher for economic activity than non-economic activity. For economic activity, the price must be calculated based on both the institution's own costs and the costs that have been covered by external public funding. For all practical purposes, the cost related to depreciation of scientific equipment is the only element in which the price calculation may be higher for economic activity than for non-economic activity: The other cost elements may be treated in the same way as for non-economic activity (chapter 2).

Note that when expensive equipment units have been fully funded by research grants or by grants for the development of large research infrastructures, the depreciation costs for these units may constitute a significant proportion of the total depreciation costs for a RIR.

The Norwegian Ministry of Education and Research's regulations (directive F-07-13, 2013) does not mention the concept 'market price', but assumes that 'market conditions' equals the full costs of services plus a reasonable margin. The question of legality arises concerning external users accessing a RIR at a price lower than the full cost rate in order to ensure high activity and efficient use of a RIR. This is an important question, especially within research communities where similar services are offered at lower prices by other institutions nationally or/and internationally, and where the industry is unwilling or unable to pay full cost prices. In this work, we have interpreted the current Norwegian regulations from the Ministry of Education and Research and the EEA to the effect that the institutions in the HEI sector may not operate with market prices which does not cover at least the full costs and a reasonable margin.

7.2 Potential negative effects on activity

Functional laboratories and scientific equipment are crucial for research of high quality. For most research infrastructures, the *fixed* costs, such as space costs, depreciation costs of equipment and the cost of technical support personnel constitute the greatest part of the full costs (often up to 80 – 90%). It is therefore vital to promote a high level of activity and efficient use. Every user hour will contribute to covering the costs of the RIR. Introducing the RIR model will in itself not cause higher activity, but full cost reimbursement of RIR expenses will provide financial sustainability and promote quality to attract researchers.

Currently, the Research Council of Norway has funding schemes with grant limits which does not allow for RIR expenses without reducing wage expenses. If asked to choose, the research communities will often favour funding wage expenses over RIR expenses; this in turn may undermine experimental research activity. Both the institutions and the public funders must take responsibility to promote active use of research infrastructures and ensure that RIR expenses are included in the funding plans for projects.

7.3 Potential barriers to joint use

Introduction of full cost and the RIR model will affect the framework conditions for research infrastructure operated in cooperation with external partners such as other HEI institutions, the research institute sector and the university hospitals. Full cost prices for use of RIR (including VAT) may, if not handled wisely, become a barrier for joint use of a RIR. This is especially true in cases where the prices increase significantly compared to current practice, and where there are no clear agreements regarding ownership and rights of use. Full cost reimbursement by funders such as the research council and EU will be the most effective measure to prevent such barriers.

Note that the framework conditions for the HEI sector are different than those of the research institutes and the private players on issues like VAT regulations, public procurement and market pricing. This makes joint operation of research infrastructure challenging to begin with. The introduction of the full costing principle and the RIR model will enhance some of the challenges, but benefits like transparency, credible prices, higher recovery of costs, and more efficient negotiations may outweigh the negative effects.