Replacement power supply

Grey school building, Nepal

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Table of contents

Initial situation

Earthquake Nepal

At the beginning of 2015, a severe earthquake struck Nepal. It claimed many lives and many people in the country lost the roof over their heads. The Langtang region in the border area with Tibet was particularly badly affected and reconstruction proved to be very difficult as the villages are difficult to access.

Figure 1: Children in Grey, Langtang region, Nepal

Grey school building

The small village of Grey in northern Nepal is located in one of the most devastated regions. The epicenter of the earthquake was around 50 km west of the village and the devastation was correspondingly great. The village's own school building was destroyed. With the help of the Freunde Tibets e.V. association, the building was rebuilt and the school resumed operations in October 2016.

Up to 150 children are taught in the school, around 80 of whom are also accommodated in the adjoining building. The school complex includes a staff room, a computer room with 25 PCs, ten classrooms and the boarding school building with eight rooms. The school building has a connection to the public electricity grid, but this does not work reliably in the mountain area. The building is primarily supplied with electricity for lighting and computers and the daily outages mean that lessons can only be held to a limited extent.

Information about the location

Grey Schoolhouse (Shree Gre Basic School), approx. 2200 m.a.s.l.

- ➔ https://maps.app.goo.gl/U969tSNdKcC91G6S7

Objective

The aim of the Friends of Tibet e.V. is to operate the buildings as energy-efficiently as possible in addition to the regular school operations and maintenance. The kitchen for the boarding school building is also being expanded. Currently, three hot meals are prepared daily for 150 children. In the rural regions of Nepal, most cooking is still done over an open fire, and the fireplaces at Grey School also still work with wood. In the near future, the new hotplates should also be powered by electricity from the roof and be able to be supplied with power in the evening using the battery storage units.

Figure 2: Pupils in front of the Grey school building, Nepal

A photovoltaic system is to be installed with which the school building and the boarding school can be operated autonomously. The solar system is to be connected to the existing grid and buffered by a battery storage system in order to store surplus electricity and make it available when needed. The Friends of Tibet Association attaches great importance to sustainability and would like to ensure operation in this way. With this in mind, the school also runs its own vegetable garden and owns two cows.

Project

Procedure

In a first step, all electrical consumers were recorded and a daily operating time was estimated. The battery capacity and the output of the photovoltaic system could then be determined based on the energy consumption. Due to the lack of technical understanding on the part of the responsible persons on site, the power compilation is rudimentary. The results are listed in Table 1.

Compilation of services			
Consumers	Power [W]	Service life [h/d]	Consumption [kWh/d]
Light: approx. 82 pcs.	4'100	2	8.2
Computer room: notebook (12 pcs.), PC (13 pcs.), printer (1 pc.)	2'500	5	12.5
Hotplates: 3.5 kW (3 pcs.)	10'500	3	31.5
Reserve	2'000	1	2
Total	19'100	11	54.2

Table 1: Power composition of the consumers

This results in a total output of approx. 19 kW. The total usage time of the appliances was estimated at 11 hours, resulting in a daily energy consumption of approx. 54 kWh.

Figure 3: "Education is the most powerful tool", children at Grey School, Nepal

Solution approach

As a result, several solutions with different products were evaluated. However, some of the devices had to be abandoned as the transportation of materials to Nepal proved to be too expensive and time-consuming.

Devices

Finally, we concentrated mainly on Victron devices, as these are available directly in Nepal. After a lengthy search, we were also able to find battery products which, according to Victron Switzerland, are compatible with the inverters and the various charge controllers.

The photovoltaic modules and substructures were also selected from manufacturers who supply materials to Kathmandu, Nepal.

Contact us

All devices were delivered directly to Team Sinergy Nepal Pvt. Ltd. in Kathmandu:

Team Sinergy Nepal Pvt. Ltd.
Banasthali-16
44600 Kathmandu, Nepal

The responsible contact person on site is Netra Bahadur Kahtri:

Figure 4: Business card Netra Kahtri, Kathmandu, Nepal

An employee of the Friends of Tibet Association, Krishna Rai, has checked on site whether the above-mentioned person and the company are legal. Krishna is a local and has been supporting Friends of Tibet for over seven years. The company we visited appeared legitimate and we are sure that the several 10'000 dollars will be invested appropriately.

Technology

Dimensioning

The initial plan was to install a single PV system on the corrugated iron roof of the Grey school. However, as the Friends of Tibet e.V. came up with the idea of supplying the new stoves with electricity in addition to the lighting etc. during the course of the project planning, the Solpic AG team decided to plan two systems directly. On the one hand, the required energy can be provided, and on the other hand, in the event of a technical fault in one system, the other can still produce electricity.

Attachment

The generator fields on the roof are created with solar modules from ZNSCHINE Solar. The "ZNSHINESOLAR ZXM7-SH144" module has 545 Wp and is installed horizontally on the south-west roof of the Grey school building. The substructure is also installed horizontally with two rails per row of modules. 20 panels are installed per system, which results in a total output of 10.9 kWp per system.

The solar radiation and the resulting energy yield were calculated with PVGIS and shown in the following table:

Calculation of expected annual yield [kWh]					
Module field alignment	Modules [pcs.]	Output [kWp]	Module power [Wp]	specific annual yield PV GIS [kWh/kWp]	Expected annual yield [kWh]
South roof, system 1	20	10.90	545	1'308	14'260
South roof, system 2	20	10.90	545	1'308	14'260
Total	40	21.80			28'520

Table 2: Expected annual output, Grey school building, Nepal

The modules were to act on a battery bank via a Victron charge controller (MPPT RS 450/200). As this device was not available in Nepal, it was replaced with three smaller Victron charge controllers. Two Victron MPPT 250/100 charge controllers and one MPPT 250/60 now perform the same task, while a Victron Multiplus II 48/10000/140/100 is installed to provide the power. A system can therefore deliver up to 10 kW of power (single-phase), and peak outputs of up to 18 kW are also possible for short periods. The Multiplus II also offers the option of charging the battery system from the public grid using the AC connection. Five 48 V battery modules from SACRED SUN are used for battery storage, one model SLSIFP51100A with 5.12 kWh and one SLSIFP48100A with 4.8 kWh. The cells in the battery elements are made of lithium iron phosphate (LiFePO4) and the total capacity of the modular systems is 49.6 kWh. The small differences between the models are due to supply difficulties in Nepal.

To connect the appliances to the existing distribution network and the various power outlets, a sub-distribution board is installed at the same location.

Communication

The various components are all controlled via the Victron Cerbo GX. This device all internal communication tasks. It is also possible to connect the device to the Victron portal via a data SIM (if a GSM network or internal WLAN/network is available). This enables remote maintenance in the event of a fault. The GX Touch is also attached as an accessory, on which all data relevant to operation can be visualized.

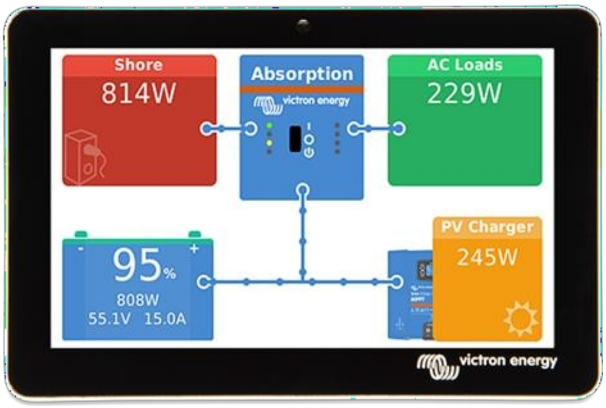

Figure 5: GX Touch as an overview and setting option

Performance

It is assumed that most appliances are mainly operated during the day and often when the sun is shining. In this case, a large proportion of the energy is supplied directly by the PV modules. The capacity of the battery storage is also dimensioned so that it roughly corresponds to the estimated daily consumption. This should make it possible to maintain the system self-sufficiently even in bad weather and with a full battery.

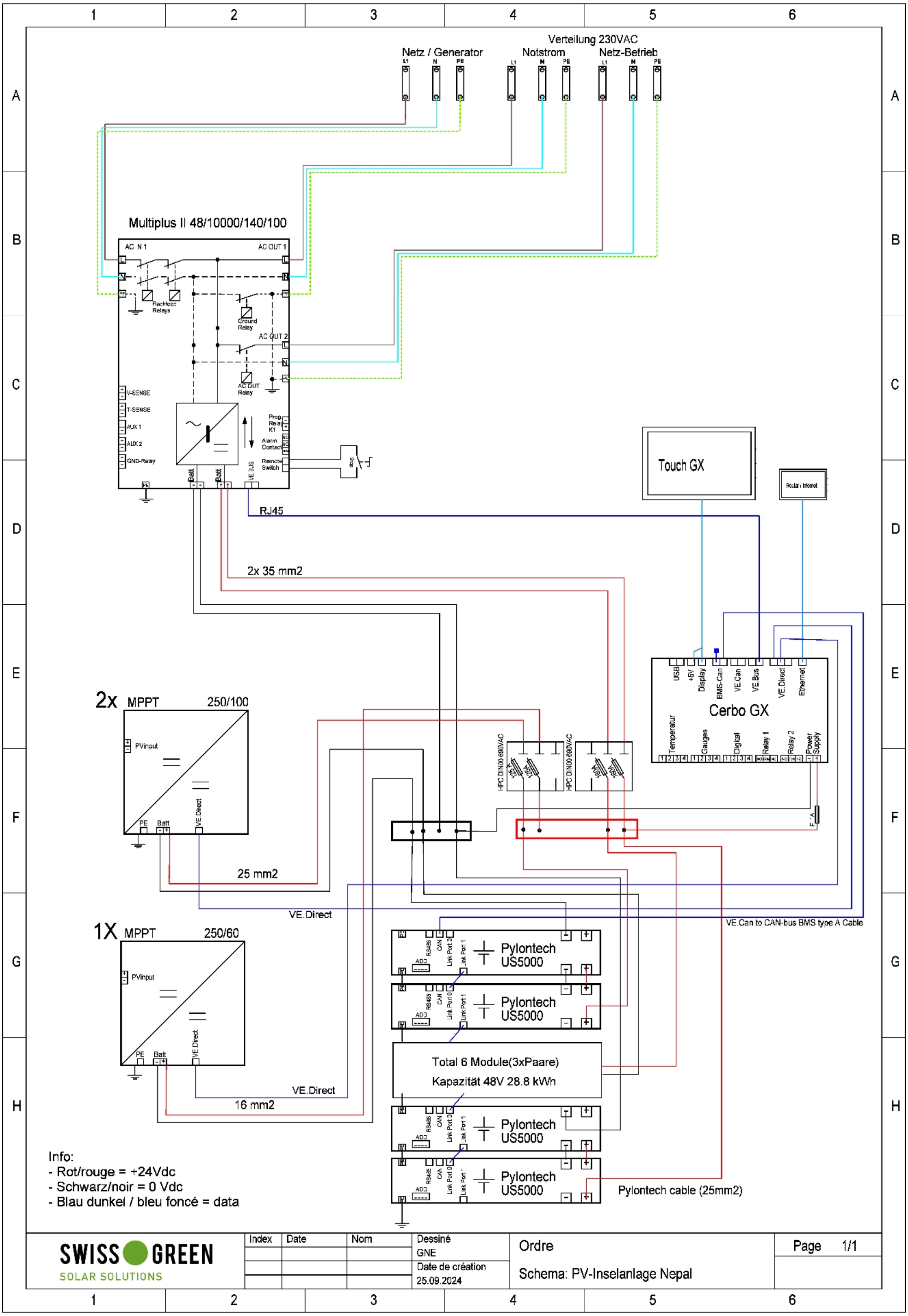

Figure 6: Schematic diagram of a system, created by Greg Anderfuhren, Swiss-Green Engineering Sàrl

Cost summary

Components				USD= 0.88801 CHF (15.11.2024)
Brand	Designation	pcs.	USD	CHF
Victron	Inverter/charger Victron Energy MultiPlus-II 48/10000/140/100	2	6'450.00	5'727.65
Victron	Solar charge controller SmartSolar RS MPPT 250/100	4		2'892.00
Victron	Solar charge controller SmartSolar RS MPPT 250/60	2		996.00
Victron	Cerbo GX	2		450.60
Victron	Touch GX	2		352.90
Swiss Green	Project support, configuration	1		800.00
Sacredsun	51.2V / 100Ah / 5.12 kWh (Total 25.6 kWh)	5	10'875.00	9'657.10
Sacredsun	48V / 100Ah / 4.8 kWh (total 24 kWh)	5	10'875.00	9'657.10
Znshine	Solar PV modules Znshine ZXM7-SH144 545Wp	40	5'450.00	4'839.65
Small material	Substructure, cables, fuses, distribution boards, GAK	1	5641.00	5009.25
Mounting material	Tools, machines, screws, etc.	1		400.00
Transportation	Material transportation Kathmandu - Grey	1	800.00	688.00
Total				40'782.30

Table 3: Total costs of the components

The costs of the project were currently borne in full by the Friends of Tibet e.V. and the company Solpic AG. The installation of the system was carried out free of charge by four employees of Solpic AG. The flight costs of between CHF 1,200 and CHF 1,700 also financed by the employees.

Grégory Anderfuhren from Swiss-Green Engineering Sàrl was responsible for creating the Victron schematics (see Figure 6) and configuring the devices remotely. This work was remunerated by Solpic AG.

Challenges

As construction projects work differently in other countries and Solpic AG primarily has experience with construction sites in Switzerland, various challenges arise:

- *Roof condition, roof structure, size, condition*

  The cost and safety of installing modules on the roof are unknown.

- *Mains connection, fuse protection, power distribution in the building*

  The local connections, fuses etc. are difficult to assess from Switzerland.

- *Delivery date batteries*

  Due to the expansion of the system in a second step, five battery modules had to be reordered. These still have an unknown delivery time.

- *Transportation Kathmandu - Grey*

  Local people have shown that the transportation of materials from Kathmandu to Grey is difficult. The roads to the school building are only passable with jeeps and transporters from Kathmandu do not dare travel these distances. There are local drivers, but they first have to the journey from the mountains to Kathmandu. The material has also doubled due to the expansion and will weigh between 1700 -1900 kg (40 modules, 10 battery modules, power electronics, assembly material).

- *Location of the system in the building*

  A wall area of approx. 4 m^2 is required for the completion of each system. The battery system can be placed on the floor, but a load capacity of at least 240 kg should be ensured.

Figure 7: "Office" power connection, Grey school building, Nepal

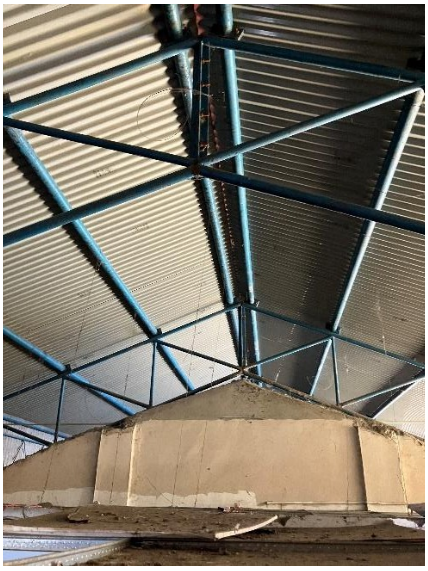

Figure 8: Roof construction

Execution

Our assembly team traveled to Kathmandu via Doha on Thursday, 31.10.2024. After the transfer to the hotel, we met the former guides of Vitus Walder and had tea, after which we started organizing the material. Together with Krishna Rai, we visited the company Team Sinergy Nepal Pvt. Ltd. and loaded the ordered material onto a truck. The components were more or less complete, but unfortunately all the battery modules were still on their way to Nepal. The truck drove to Grey without batteries and also without tire tread. Although the village is only about 50 km away as the crow flies and the roads are shorter than 150 km, you have to allow around ten hours for the journey.

Figure 9: The village of Grey in northern Nepal

Figure 10: Grey access road

Most of the required material was now in Grey, but small and assembly materials still had to be organized. Due to the Divali Festival of Lights, some stores were closed and our team had two days for sightseeing around the capital. Afterwards, we also headed north by jeep. A stopover was before the village of Dhunche to find the missing materials.

We arrived in Grey in the evening and Pema, the wife of the head teacher at the school, welcomed us to her homestay. The next morning we visited the Shree Gre Basic School. All the teachers, parents and children gave us a warm welcome. The team then got down to work and identified the locations for photovoltaic systems, technical equipment and power connections. The material was then unloaded and all the parents present, especially the mothers, gave us their active support (Figure 11).

The work took more than four days and many steps had to be improvised. The systems could not be installed on the main building with the blue roof as planned, but are now located directly in the building behind the playground. The inverters, charge controller DC connections and the control units could all positioned in the same room.

Figure 11: Active support for mothers

Figure 12: Fully assembled system 1 and 2

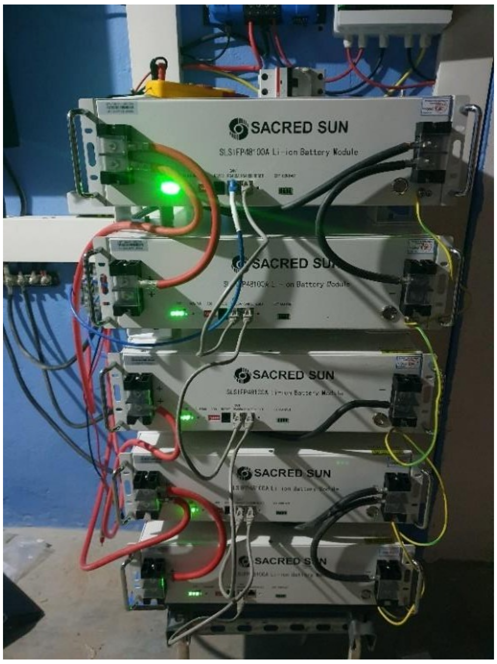

Figure 13: Connected battery

We built an elevation for each of the battery modules to protect the devices from water in the room during the monsoon season. Unfortunately, the commissioning could not be completed on site as the batteries were not delivered until we had to leave Nepal. However, the control system of the Victron components an interface that is connected to the Internet and allows remote maintenance. In addition, the supplier promised us that he would send an engineer who is familiar with Victron devices with the delivery.

The systems were brought from Switzerland two weeks later by Vitus and with the help of the engineer and Krishna on site. Commissioning in Nepal took longer than initially expected, but the devices successfully put into operation and the apparent yields and consumption are appropriate. Most recently, 39 solar modules with a total output of 21.3 kWp were installed on the roof. The energy from the roof is converted by two 10 kW inverters and the battery modules have a total capacity of 49.5 kWh.

Figure 14: Completed PV system on the roof, 21.3 kWp

Figure 15: Electric induction hotplates in the kitchen

The two new systems bridge the daily power cuts from the grid. Cooking in the kitchen is also made much easier and healthier: Three induction hobs replace the previous hob. Thanks to the batteries, cooking for the children in the hostel (boarding school) also possible late in the evening.

Appendix 1

Production and consumption

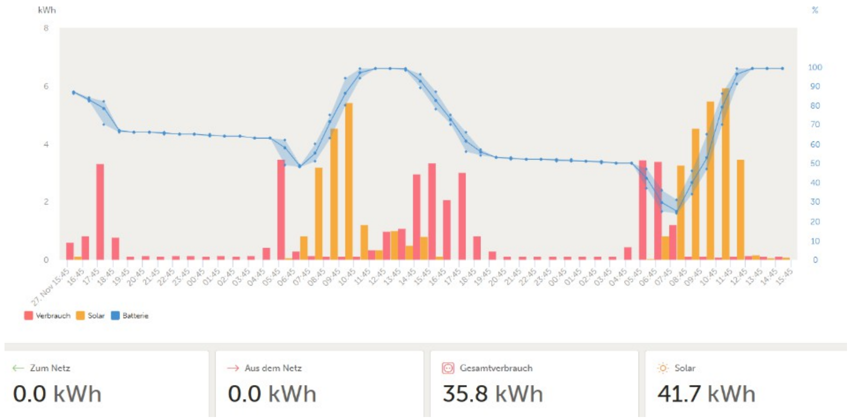

Figure 16: Course of the day, system 1

Appendix 2

Production and consumption

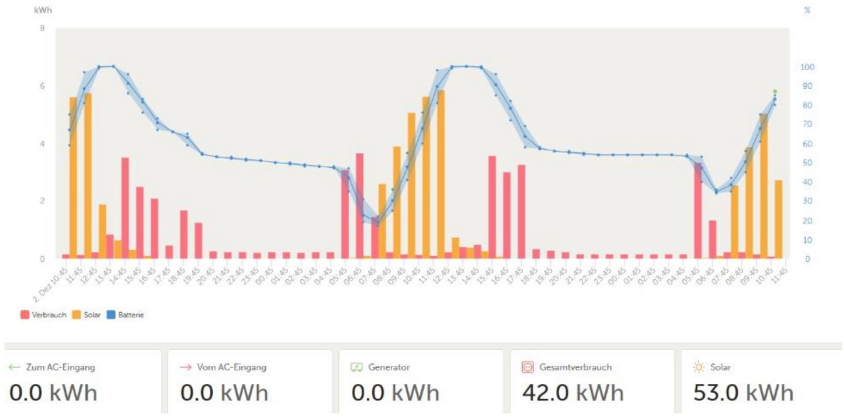

Figure 17: Course of the day, system 2

Sponsoring

This is a project close to our hearts, for which we as a company and as private individuals work free of charge and have financed from our own funds. We are dependent on your support for a successful implementation. As Solpic AG, we are very grateful for every donation. We will of course keep you up to date and inform you about further investments If you make a donation, we will also be happy to list and link you on our website. A video will also be produced to provide a retrospective, and we can also your company logo into the video if you are interested.

Thank you for your trust and your help.

Donation requests can be made directly to the Managing Director Vitus Walder:

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Kind regards

Vitus Walder & Team

NAMASTE!

Figure 18: Final picture Grey, Nepal

List of illustrations

List of tables