Hi-rise timber building

Part 2

Växjö, in Southern Sweden is a town with the big eco-ambition to be 'fossil-fuel free' by 2050. As part of the plan they have turned the town into a timberbuild hub, and become a knowledge centre in building timber hi-rise, including the first eight storey timber PassivHaus buildings. In the second of his two-part series on Europe's emerging timber hi-rise community, Oliver Lowenstein reports ...

Until recently, Sweden's architectural scene has not exactly been bursting with memorable timberbuild projects, unlike Norway and Finland where there is a new generation of young architects excited and engaged with the material, and exploring the potential of the resource on the doorstep. Rather, what appears to have advanced furthest in Sweden, are joined-up projects developed from a strategic approach to their vast and renewable reserves of growing energy which its forests embody.

In 2005 Sweden set a goal of energy independence – with 49% renewables - by 2020[1], forgoing the nuclear energy option. In March this year, the government's updated energy plan, continues the 50% renewables target and committed to 40% carbon emissions reductions by the same date, even if, three years on, closure of current nuclear plants have been put on hold[2]. Although the timber industry is apprehensive at woodlands being used less profitably, for biofuels and building projects, timber is central in this renewables' strategy.

Looked at this way, rather than from the usual straightjacket of architectural thinking the timber hi-rise currently being developed in the Swedish town of Växjö - the focus of the second of this two part timber hi-rise story - becomes significantly more interesting; part of a much broader strategy contributing to drawing down the entire town's energy and carbon footprint, an avant-example of how an entire whole urban area could potentially go carbon neutral. Indeed the hi-rise initiative comes on the back of the town being one of the early European front-runner urban centres to seriously embrace and attempt to green itself, making the reduction of its ecological footprint a serious priority. Dating back to 1993 when the municipality decided to pursue a low-energy strategy, both for practical and pr presentational reasons, Växjö municipality has managed to reduce its carbon emissions by 32% between 1993 and 2007. The aim is to push this down to 50% of the 1993 level by next year, 2010 and 70% by 2025. The strategy has been three fold, focused on lifestyle, improving the health of the surrounding natural world, and finally a commitment to a 'fossil-fuel free' city[3]. Apart from these dramatic footprint reductions' targets there are other tangible benefits; the surrounding lakes are no longer polluted, and increasing amounts of local agriculture is being farmed organically. There's also been recognition; Växjö was awarded the Sustainable Energy Europe Award in 2007, bringing international media attention. Much of the footprint decrease - over 90%, the city's website and those I talked with while visiting Växjö each acknowledge this - has been due to moving the city's heating plan over from oil to biomass. In the wake of these successes both practical and in profile, there's now another tranche of sustainability expertise the city can wear on its sleeve. The municipality, along with the university engineering research departments and local timber and forestry companies, is becoming increasingly recognised as a knowledge powerhouse on timber - from forestry practice right through to timber as highly engineered material. It's from this that Växjö's timber building community and its speciality in timber hi-rise has developed.

Facing out over the lake, the Limnologen site feels placid and peaceable, at least on a summer's day.

Drawn around a cross between a T and a semi-triangular plan, each of the four cross laminated timber buildings narrow towards the lakeside front. Each floor contains 5 apartments and each block 134 apartments.

As a major forestry region in the southern Swedish county of Smaland – with 1600 forestry related companies in the area – it's not completely surprising that Växjö was quick off its feet when the Swedish government committed the country to using more wood in construction, in the aftermath of a major national report in 2004[4]. With both national government and industry players beginning to focus on increasing timber in construction, research funding aimed at facilitating this increase began to become available. Växjö University connected into this in terms of timber technology, with the young university – it had only been granted university status in 1999 – already opening its Institute of Wood in 2002, within the first and most ambitious of a series of academic timber buildings on its campus, the 15,000m^2 Timber Research Centre, which at the time it was completed, was the largest timber building in Sweden. The only south Sweden timber research centre – the others being Luleå in the North, and Falun in the mid north-west of the country – the university's strategic aim of developing structural engineering and timber technology converged neatly with central government's timber in construction priorities. This has been, says professor Erik Serreno, the head of research into structural engineering, the department's primary focus for some time.

Three years later, in 2005, the municipal council announced its 'More Wood in Construction'[5] programme, allocating a relatively unused stretch of land between two lakes, Trummen and Växjösjön, known as Välle Broar, which joins the town centre with the edge-of-town university to the town's south, as the main initial site. Välle Broar, at 225 hectares, is envisaged as a complete wood town, with homes for between 1000 and 1500 people, although unlike previous wood towns, like those in Finland, the focus wasn't on single family homes. In place, underwritten in part by both the local programme and the five-year national timber programme, the emphasis has been on promoting the use of wood in medium and hi-rise building. Such a focus, at both the governmental and regional level, wasn't a complete surprise, given that legislation in 1995 overturned laws forbidding timber buildings over two storeys dating back 120 years to 1874. This legal turnaround came after a century of fire regulations forbidding timberbuild of any height. As in Finland, Sweden suffered a series of calamitous fires razing parts of towns – including Växjö in 1838 and 1843, and the northern towns of Sundeland and Umea on the very same July day in 1888. These disasters brought on the legislation outlawing multi-storey timberbuild, a situation which lasted until 1994.

With Växjo already well into its greening programme strategy, and the university building up its timber engineering profile, Hans Andren today recalls the sense of anticipation around timber. Andren, who runs the business side of the Centre for Timber Construction and Housing (CBBT), says that although the regulation wasn't in place at the time of the decision to build the Timber Research Centre, many of those involved, from academics, municipality officers and Södra; the Southern Swedish timber umbrella organisation with 60,000 members - the

In focus: timber hi-rise

largest member owned forestry company in the world - could feel this time for timber was in the air. By 2001, there was the sense that 'something was coming up'. "Carpentry was rolling up everywhere, there was all this competence around, so it was around that time that things happened through many meetings, all between a small group of people," Andren recalls.

At the heart of Välle Broar is Limnologen, a four building mid to hi-rise residential series of apartments. Although there had been a prototype mid-rise building near-by - Välludden. - completed in 1995 with funding from Södra, it was only once Växjö's town council committed to the greening strategy, that Limnologen was initiated. Designed by Arkitekt Bolaget, a seven person local Växjö firm who seems to have cornered the market for much of the town's larger projects, the four eight storey towers sit off by the lakeside of the road south out of the town. Facing out over the lake, the Limnologen site feels placid and peaceable, at least on a summer's day. Drawn around a cross between a T and a semi-triangular plan, each of the four cross laminated timber buildings narrow towards the lakeside front. Each floor contains 5 apartments and each block 134 apartments. Cost is apparently level pegging with concrete, at about 2000 euro, including underfloor heating. While not cutting edge the buildings aren't hard on the eye, in part a result of the extensive balcony system which wraps around each floor, to be used by those living in the apartments just to sit out on, relax or eat meals on. The building's render has also been painted a sandy brown, part of the Swedish house-building tradition. The few people I talked with seemed pleased with the flats, commenting on how pleasant they are with views out onto the lakeside.

For those professionally involved Limnologen was about demonstrating that medium hi-rise was technically possible, showing how timber can be applied for these sorts of hi-density residential buildings. The buildings also represent the convergence of the Timber Research Institute's engineering aspirations with the Växjö's low energy strategy, in effect an added element to the biomass which has underwritten so much of the town's reductions to date. To give this overlap in agendas teeth, Limnologan uses many locally produced components and resources in the Växjö construction industry. One of the four blocks was built to low-energy standards, which meant reducing window size, and is, so Vessby states, the first passive house hi-rise building, "to be built from wood."

Ola Malm, the project architect, believes Limnolegen is a development of Arkitekt Bolaget's timber thinking. For as a practice, the firm had decided over twelve years earlier to develop their wooden architecture expertise. With a number of previous timber projects already to their name, Arkitekt Bolaget proposed five 5 storey residential blocks in their response to the limited Välle Broar competition invitation, in which six architectural practices and six landscape architect firms participated, going on to develop Välle Broar's first stage.

Some time after being announced the competition winners in late autumn 05, the practice was asked to design four buildings, all 8 storeys in height. Looking around for timber companies with the right experience, and after several meetings with various factories, Malm decided Martinsons, the large North Swedish timber firm based in Bygdsiljum, Umea, was best equipped to deliver the building. Martinson's experience counted, since they'd already developed earlier trial systems, including that of a six storey massive wood residential block, Inre hamnen in Sundsvall, again in Northern Sweden, and a similar, adapted version was developed in the town of Lumle. Martinson's also offered the client, developers Midroc, a contract where they would be responsible for the entire build up until the completion of the external walls and floors. Only then was the building handed over for the inside walls and apartments to be kitted out. As a result Limnologen applies the same principle, with massive wood applied to both walls and floors, similar to Martinson's approach at Inre hamnen. The internal walls, however, have been significantly thickened, for sound insulation, and now comprise three layers; 2 vertical and 1 horizontal, around 85mm thick plus insulation. The flooring is divided into cross laminated slabs consisting in a mix of strengthened 2400mm wide 3 layer slabs and non-strengthened elements joined to glulam beams for load-bearing strengthening. The elements top-layer comprises 73mm thick CLT board, the glulam beams running underneath, and insulating mineral wool in the spaces between. Ceilings sit separated from the load carrying elements, self- supporting on the rooms vertical wall sections as part of the sound insulation strategy. In all there are 30 floor elements per floor.[6]

The four buildings sit on a ground floor concrete slab,

Växjö University opened its Institute of Wood in 2002. It was the first and most ambitious of a series of academic timber buildings on its campus. The 15,000m^2 Timber Research Centre, at the time it was completed, was the largest timber building in Sweden.

as the foundations needed to be piled into granite hard rock, the concrete also stabilising the building's down pressure dead loading. In addition, as further stabilisation against wind pressure on the upper floors, 48 steel tension rods run vertically through the building. The rest of the building, from the first floor up, is timber. Each floor took about 10 days to complete, the total seven floors structural engineered cross-laminated timbers went up in fourteen weeks. "Very quickly," says Vessby. Almost all walls apply the cross-laminated timber system, each with three layers in both walls and floors. The floors are glued to the structural glulam beams which helps minimise vibration. With each floor housing five apartments. The building, as can be seen in u-tube clips[7], was housed in a temporary tent structure, key protection against the cold, Swedish winter with rain and snow potentially deforming the wood, ensuring the timbers were kept dry. This worked very well, says architect Malm. "It was warm and dry and smelt good. It was really nice. Even if it costs a little more, there are other advantages." It's been, he adds, "a really interesting project." Researcher Vessby also underlines the projects positive effect, "it's definitely been very successful for the regional timber industry". In research terms the main focus has been on vibrations, and stabilisation against wind loads. The sound insulation has been effective, Vessby states, there being only minimal sound transmission between walls and floors. There is ongoing research into moisture content, while the gluing research is focused on optimising both the gluing beams and the use of timber to be as efficient as possible.

For those involved, not least CBBT's Andren, these first four blocks are only the beginning of Välle Broar, which is presently envisaged as a ten-year programme, with one or two new buildings completed annually, each to the tune of around 2 million euros. Next up at Välle Broar are two smaller housing projects; Pellerfalen 1 and 2. These two 5 or 6 storey buildings will hold 60 flats and are being developed by a housing co-operative in collaboration with Setra, another forest owner's group, this time from central Sweden. At present these are to be highly pre-fabricated timber frame constructions in box form, with milling close to Växjö as the forestry group do not own factories. There's also the first timber passive hi-rise, which I'll return to shortly. Andren is part of the Nordic Wood Cities network[8], which includes towns and cities throughout all five Nordic countries. But with Välle Broar already a third of a way through its ten-year programme, Limnologen built as well as other timberbuild projects, and new projects on the way, Växjö is ahead – in terms of completion of projects, people moved in and living, and next moves off the drawing board - of these regional Nordic urban centres bringing timber back into the urban build equation.

At Limnologen, the floors are cross laminated slabs consisting in a mix of strengthened 3 layer slabs and non-strengthened elements joined to glulam beams for load-bearing. The elements top-layer comprises 73mm thick CLT board, the glulam beams running underneath, and insulating mineral wool in the spaces between. In all there are 30 floor elements per floor.[6]

Yet. of course there were previous projects, and Välle Broar are not the first timber buildings completed in Växjö. All those I talked with began the history lesson with two smallish buildings completed between 1992-94 in Välludden, a short distance away from Välle Broar, consisting of 15 and 17 apartments respectively. These were followed in 1994 by a further 4/5 storey building block for approximately 40/50 apartments. The 1994 buildings used a stick 2 by 4 system. Externally rendered with plaster, the buildings none the less used "quite a lot of wood." After this early spurt, timberbuild came to a halt with the disappearance of a market. When I ask Vessby and Malm about these early days, they respond by saying that at the beginning of the new century developing timber presented "large difficulties," foremost among these the lack of specialist knowledge. In a well-known story, repeated across the whole sector, architects, builders and those in construction were all lacking in relevant skills and experience. "And developers didn't know how to calculate the costs of timber buildings." Conversely the advantages of concrete, with the industry knowing all about the material, added to the difficulties in changing. The laws of entropy and inertia, as with much of Europe, maintained the concrete companies.

Yet all was not stasis. Arkitekt Bolaget had, by this time, committed to timber as a material, while timber engineering had emerged as a university centrepiece. However, even if Växjö was in Sweden's timber heartland, knowledge of cross-laminated timber was minimal. Malm discovered a small husband and wife timber company outfit, Ekologi Byggarna, importing and distributing massive wood from Vorarlberg and other producers in Austria. He remembers looking at the material and realising the potential in cross-laminated timber. After

some further research Malm and others close to the early timber developments made the journey to Austria, and were astonished to find how advanced the material was in Austria's showcase eco-architectural county. "They inspired us, all of it - the architects, the universities, the builders," recounts Malm today. He remembers visits where the Swedes marvelled at the engineered wonder-wood, and also the level of craftsmanship in the detailing and finishing. In the hidden history of the re-emergence of timber some may find it astonishing how often Vorarlberg seems to crop up. The influence led to Vorarlberg's travelling exhibition, Constructive Provocation, being shown in Växjö, its only venue in Sweden, along with visits from various Vorarlberg architects and engineers, including Johannes Kaufmann.

At the same time the university had set in motion the construction of two major timber buildings, the first of these being the Institute of Wood, which opened its doors in 2002. Designed by JaisNielsonWhite Arkitektur from the neighboring town of Helsingborg, Hus M, as it is known, is the first and most ambitious of the university's timber buildings so far. Hus M's 15,000m^2 houses the Timber Research Centre, along with other research departments and remains, at least by size, the largest timber building in Sweden. The building sits in the heart of the new campus alongside a string of somewhat anonymous academic office boxes. Certainly sizeable, the open entrance atrium space is backed up in place by a glulam beam and post system, before stairwells provide access to first floor offices.

At about the same time – 1999-2002 - Arkitekt Bolaget was completing the second of the university buildings, Uppfinnaren, described by Andren as an 'Office in the Sky.' This four floor university research block is one of the more expressive buildings on the campus. Uppfinnaren was intended to meld timber to the working office environment. Using a concrete slab – unusual in Sweden, apparently – to help cool the naturally ventilated building, 8 large glulam timber columns support the main structure, with a further triangular column and beam system supporting the two upper floors. These jut out assertively at the front, providing a sheltered foyer area, and giving the elephantine impression, at least to me, of a marching animal. Andren refers to the building as 'aggressive' although aesthetic of its cuboid angularity is more restrained compared to various Germanic cousins.

If the first chapter of the municipality's programme to green Växjo was focused on shifting from oil over to biomass, overwhelmingly organised around the town's heating plan, timber building is now a second chapter in the ongoing story. This is now moving quickly on. A number of recent projects add to the timber profile; a wood frame bridge using wood-glue hybrid beams, joins an off road cycle route between city and university. South of the bridge is the site for House N, a 5000m^2, 3 floor building, scheduled for completion this autumn. There's also, Derome, a company from Sweden's west coast, who owns sawmills with hi tech pre-fabrication facilities, want to build a 'timber construction platform, which connects between the 2 by 4 system and an element system. Near the university's entrance there's also Växjö's police

Insight

Chris Laughton

Contractions and superlatives

Contractions and superlatives remain the bane of our lives. If there is ever a temptation to shorten a word or phrase and then apply unnecessary praise to it, you can be sure someone will. Take for example the current buzz phrase 'zero carbon'. This hyped-up slogan now permeates government policies, quangos and advertising slogans up and down the land. Few, if any, can provide any meaningful definition so it remains an intangible term which serves only to confuse and dilute an important message. The recent publication by the Department of Local Government and Communities of the summary of responses to the recent consultation on 'Zero Carbon' confirms that this phrase has no common understanding. We may never know the name of the bright spark who decided on the need to reduce 'atmospheric anthropogenic greenhouse emissions including carbon dioxide' down to simply 'zero carbon'. But there we have it, and so I'm even being told that my house would be better if it were 'zero carbon'. I beg to differ.

In fact, we should be doing the opposite with our houses. We should make them 'high carbon'. By this I mean we would be best off filling them with timber products, hence sequestering those devilish carbon atoms that lie entombed in the cellulose structure of wood. I also particularly like carbon atoms because they form part of my bone structure and help me stand up straight. I could labour the point, but there is a fundamental difference between elemental carbon (C) and the gaseous molecule of carbon dioxide (CO_2). I'm sure every reader of Green Building is quite clear on that concept, and we make the associated mental gymnastics every time the 'C-word' appears. But spare a thought for our younger generations bombarded with such misnomers. They struggle to pass even those basic science exams that require them to distinguish the elements of the periodic table and their compounds. Do we really need to make science ever more impenetrable with our lazy, know-all jargon which ultimately defeats its educational mission?

You can be sure that for every confusing contraction in our language, some teacher somewhere has to spend extra time in a classroom untangling the confusion. Of course, it doesn't simply stop with carbon. Every time I take to the roads, I'm told by a government sign that 'speed kills'. This essentially false statement, albeit with good intentions, means to say that if we strike hard surfaces at high speed then we are unlikely to survive. Given this, it would be far better if the signs simply stated the truth, such as 'impact kills'. Then I wouldn't feel as if taxpayer's money is being wasted on disinformation.

Leaving semantics aside, it all becomes poignant when so called 'zero carbon' technologies are found to contribute excessively to global warming gases from their production methods and then are even worse at the end of their use. The Silicon Valley Toxics Coalition (SVTC), which promotes human health, 'green' chemistry and environmental justice in the photovoltaic (PV) industry, indicates considerable concern in its publication 'Toward a Just and Sustainable Solar Energy Industry'. The list of undesirable chemicals used in PV production has to be seen against its supposed 'zero carbon' credentials, which include trichlorosilane, hydrogen selenide, gallium arsenide, phosphine, arsine and trichloroethane. But it's the greenhouse gases of sulfur hexafluoride and nitrogen trifluoride which really scupper the claim of PV to be held in the 'zero-C' category. These would be the top two Kyoto-recognised greenhouse gases, each equivalent to over 15,000 of the greenhouse warming potential of carbon dioxide; although mysteriously, the latter is not listed. We need a much better and fuller lifecycle accountability for PV with a supplier take-back at the end-of-life. Given the UK government's intention to only permit zero carbon homes from 2016 on the basis of reducing global warming, I am amazed that PVs can seriously be considered as qualifying. This is a clear case of 'zero-C' as an insufficient and unreliable phrase for a sustainable society. This misuse of the word carbon is not so much greenwash as a new 'carbon-wash'. The problem is that this wash leaves us distinctly dirtier than before. There are already signs of previously unheard-off eco-buzz words being groomed to replace the beloved 'zero-C'. As with all buzz-words these take the form of new grammatical contractions, as if to suggest they are only intended only for those already in the know.

The term 'microgeneration' has been neck-and-neck in the race for most nonsensical gobbledygook along with 'low-c' for quite a few years now. This was originally suggested in order to sneak combined heating and power in with the initial enthusiasm for renewables. It's been a strong contender but is now starting to wane in government circles in favour of the fresh-faced 'cleantech'. This should do quite well since it meets all the expected criteria of government hyperbole, particularly in that it is ill-defined from the outset. Cue a consultation definition exercise in a few years' time, no doubt. Education departments instead seem to favour 'enviro technology' as their contestant in the race although I suspect it will not last the course since it is a tad too long, although its vagueness will keep it favoured by many a politician. If we really must have a catch-all piece of jargon to make everyone look like they are on the right track then we could just revert to saying what we mean and really need – sustainable heat and electricity.

academy, a small training building, again timber, the design of which Andren chortles was 'stolen' from Vorarlberg.

Most interesting for quite a few, however, is the latest semi-completed project at at Välle Broar; two further eight storeys, though this time passive hi-rise, Portvakten, a part-commercial, part-research project, which began as Limnologen neared completion. These 64 apartment zero-energy buildings, again involving smaller windows, and is, so Vessby states, the first passive house hi-rise building, "to be built from wood." Given the passive character of the two tower blocks, a main difference is in the insulation, with very much thicker floor and walls. Also a larger part of the building was prefabricated. Visually, however, the Portvakten buildings are pretty shoddy; and some of those I talked with were clearly disappointed, wistful even, about how the rather unique architectural opportunity to build Europe's tallest passivhaus towers had been passed over in favour of the most economic designs.

Still, for the timber research institute, Limnologen, is a gift of sorts, providing a wealth of new and on the doorstep research. Vessby points out how much more useful applied research has been to the theoretical work that had preceded it. Limnologen offers the live context of a real life building, enabling modelling, maths and theory to be applied to the real life context. The other two main research areas has been energy/carbon reduction issues, and on technological development to enable wood to be more closely suited to industrial processes of the regional industries. Also unusual at Växjö is a focus on the complete chain, while the materials research is in composites, particularly wood-glass hybrids; the Institute being involved in research titled Glafo - producing a prototype wood-glass beam as an initial result.

All told Andren says, there are 30 to 40 similar if smaller less ambitious projects around Sweden, with one in the county of Darlena in the north being the most ambitious. But he is adamant that there are no others of such scale and ambition as Välle Broar, sitting in a city district, in Växjö's case between the city centre and the university. "We have this project which is quite big, and we cannot find any other place in Europe which is planning anything like this, a whole part of a city. We're doing it all openly and transparently and more and more understand what we are doing."

A steady trail of international visitors have made their way to Välle Broar, from the international media, including the BBC and CNC, as well as other European and Japanese TV companies. There's also been researchers from Germany, the neighbouring Nordic countries and also from the Canadian Forest Research Institute. The word is getting out. At present in Sweden there are a number of other medium to hi-rise buildings either complete or under construction, including a 10 storey housing block being renovated in the southern Skåne part of Sweden, while in Helsingborg there is housing of up to 5 storey; another node in the Nordic Wood Cities network.

In a recent phone conversation Andren was keen to talk up wood as a high performance, highly pre-fabricated material. With the statistics showing the overwhelming majority of Växjö's energy footprint reductions have come from biomass the question is whether and how the town is going to go meet its reductions targets of 50% by next year, and then the further reductions in the next four decades. Biomass, says Andren, is one leg, and now timber building is the other leg. "It's about developing a better way." This is fine as far as it goes, although asked what will most influence the reductions next Vessby points to the traffic, and suggests not much has changed there. Andren, gently pushed on this, is somewhat vague, talking of car-share schemes, and a transport strategy, but not of what's been achieved thus far[9]. And legally Välle Broar is the only one of Växjö's current rosta of six developments, which is bound by stringent timber construction constraints. Elsewhere developers are requested to use wood if it is possible, as well make accessible the resulting $C0_2$ figures and situation, and what has happened.

There's palpable excitement among those I talked with that both town and university contain both the most focused research group and set of buildings in hi-rise and related structures in Europe. Serrano believes the time is now right to look outward to mainland Europe, and while mid-rise is a niche area, they've certainly put Växjö on the timber map. As with most other research hives where timber hi-rise research is happening, Växjö isn't immune to pondering how high they might go, Vessby observing, of there being "continuous discussion about how high we can go. We're looking for the limits, of course."

Looking out across Trummen lake, I asked Vessby what the good citizens of the town – which is adding between 1000 and 1500 inhabitants per year – know about all this work to green the city. "You know," says Vessby, looking almost puzzled, "it's something I've never understood. People are quite aware of environmental issues generally, and they're very happy about this, Limnologen. But how much they know of what's going on in Växjö, that's very difficult to tell." The lesson seems to be that you can get quite a long way, so far as how people's lives are lived aren't too changed or challenged. I can't help think the next chapter will be different. If it's unfair to say that Växjö has done the easy bit, it's still going to be very interesting to see how this small Nordic town with big eco-ambitions will go about tackling what is unambiguously harder – the human element.

Oliver Lowenstein

Refs.

1. See for instance John Vidal in The Guardian 8th Feb 2006
www.guardian.co.uk/environment/2006/feb/08/frontpagenews.oilandpetrol

2. For the Swedish Governmental latest energy plan see
www.google.com/hostednews/afp/article/ALeqM5jK1pcDnmSIQ_KzXDfMi27YiOEM-A

3. See Vaxjo Commune's Environmental Programme, particularly pages 1-3 downloadable as a pdf at
www.vxu.se/td/forskning/publikationer/index.xml

4. The 2005 National Timber Programme see (in Swedish)
www.regeringen.se/sb/d/5903

5. See introduction in Documentation of the Limnologen Project. Overview and Summary. School of Technology and Design Reports, no 56

6. For a detailed analysis see again the Limnologen Project Overview and Summary,

7. To see the building going up look at www.vxu.se/td/bygg/trabyggstrategi/limnologen/film _ om _ bygget/index.xml?file=medium

8. www.nordicwoodencities.com

9. Looking through the commune's Environmental Programme a relatively detailed set of targets are outlined. These include increasing ecological farming from 19% in 2005 to30% by 2010, and ensuring 25% foodstuffs are ecologically sourced by 2010 (compared to 4% in 2005) In travel, probably the most challenging area to make a critical impact in, there are targets of increasing cycle traffic by 20% by 2010 compared to a 7% increase in 2005 on 1995, and use of public transport by 20% compared to 2002. It actually decreased while decreased by 11% between 2002-2005 within the city. All these are about human behaviourial and lifestyle change. If it works they will achieve the all round aim of carbon emissions reduction by all residents of 50% by 2010 and 70% by 2020. But note that on emissions of fossil carbon dioxide, these increased by 2% in 2005 – and the aim is to draw this down by 30% by 2015

Other useful links

www.vallebroar.se

www.vxu.se/td/english/civil/research/limnologen

www.vxu.se/td/bygg/trabyggstrategi/limnologen/vrml

www.vaxjo.se/VaxjoTemplates/Public/Pages/Page.aspx?id=1664

www,architektbolaget.se

www.sodra.com