

BIOENERGY KNOWLEDGE CENTRE



Bioenergy Update March 2008

The Bioenergy Knowledge Centre contracts Energy Library to source and disseminate publications, journal articles and conference papers relevant to the use of New Zealand woody biomass resources for the production of energy and generation of additional revenue for forest owners. This update is produced regularly.

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Books and standards

AS/NZS 4014.6 2007 Domestic solid fuel burning appliances - Test fuels - Wood pellets.

Specifies test methods for assessing pellet test fuels used when determining the power output efficiency and particulate emission of domestic solid fuel appliances.

(To request email library@energylibrary.org.nz and quote **Bio5-Standard**) ✓

Biomass gasification technology and biomass energy workshop. (2008)

Christchurch, N.Z.: Wood Technology Research Centre, University of Canterbury

Presentation notes from a seminar held on 13th February 2008. Presentations included:

- Where may gasification fit in the NZ bioenergy market
- Overview of up-to-date progresses and challenges in biomass gasification
- Biomass steam gasification - A success story in Austria
- Latest development and progresses on the 100kW fast internal circulating fluidised bed gasifier
- Energy demand and biomass supply in NZ wood processing plants
- Biomass gasification: Feasibility study into the potential for biomass gasification in the NZ wood processing industry
- Experience in running a commercial scale 2MW gasifier test plant

(To request email library@energylibrary.org.nz and quote **Bio5-Workshop**) ✓

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The air gasification of woody biomass from short rotation forests: opportunities for small scale biomass-electricity systems. PhD thesis. (1997) Kingiri A. Senelwa. Massey University, Palmerston North.
(To request email library@energylibrary.org.nz and quote **Bio5-Thesis**)

The biomass assessment handbook: Bioenergy for a sustainable environment. (2007) Frank Rosillo-Calle (Ed.) et al. London: Earthscan.
Contents:

- Overview of biomass energy
- General introduction to the basis of biomass assessment methodology
- Assessment methods for woody biomass supply
- Non-woody biomass and secondary fuels
- Assessment of biomass consumption
- Remote sensing techniques for biomass production and carbon sequestration projects
- Case studies

(To request email library@energylibrary.org.nz and quote **Bio5-Handbook**)

Current Articles

The 25% vision: A transformational energy policy. Richards, Bill. *Renewable Energy World*; Nov/Dec 2006 Volume 9 Number 6. p.113-117

This article is by the Co-chair of the 25 by '25 renewable energy programme, which calls for agriculture and forestry to contribute 25% of U.S. energy needs by 2025. He discusses the reasons for such an aggressive goal. As at the end of 2006 the programme had gained endorsement from influential groups. Technological advancements (e.g. in the manufacture of cellulosic ethanol) will be instrumental if the States is to reach the target.

(To request email library@energylibrary.org.nz and quote **Bio5-Richards**) ✓

Effectiveness of policy instruments for supporting the use of waste wood as a renewable energy resource in the Czech Republic. Bohumira Jehlickova and Richard Morris. *Energy Policy*; Volume 35, Issue 1, January 2007, p.577-585

This paper focuses on an examination of the government's strategy for encouraging the use of wood as a renewable fuel in Czech households. It examines the development of modern combustion technology and its impact on the environment. It describes the estimated requirement for wood by an average household and examines the overall availability of wood as a renewable fuel in the Czech Republic. The paper analyses in detail the policy instruments used by the Czech government to promote the use of this technology. It evaluates the impact of this policy on the users of the technology and practical achievements of the policy measures with respect to the overall objective that is the promotion of generation of renewable energy.

(To request email library@energylibrary.org.nz and quote **Bio5-Morris**) ✓

Trace element enrichment and behaviour in wood pellet production and combustion processes. Boman, C. et al. *Energy and Fuels*; Vol. 20, No. 3: May 2006, p.993-1000

(To request email library@energylibrary.org.nz and quote **Bio5-Boman**)

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The path forward for biofuels and biomaterials. Ragauskas, A.J. et al. *Science*; 311 (5760) 2006, p.484-489

According to the authors of this paper biorefineries are the way of the future. They outline the advantages of using biomass to manufacture biofuels and other bioproducts (eg bio-derived plastics and solvents). Assuming ongoing advances in manufacturing technology and crop science, biorefineries offer the potential for development of sustainable biopower and biomaterials on a large scale.

(To request email library@energylibrary.org.nz and quote **Bio5-Ragauskas**)

Pyrolytic characteristics of blended coal and woody biomass. Behdad Moghtaderi et al. *Fuel*; Volume 83, Issue 6, April 2004, p.745-750

Pyrolytic characteristics of biomass/coal mixtures were investigated under conditions pertinent to pulverised fuel boilers. It was found that the mixtures of biomass/coal follow the behaviour of their parent materials in an additive manner. The two fuels did not chemically interact under inert conditions indicating a general lack of synergistic effects. As such, the yield of the major pyrolysis products is linearly proportional to the percentage of biomass and coal in the mixture. Even the compositions of the gaseous products from blended samples are linearly proportional to those of their parent fuels. These findings can potentially help to understand and predict the behaviour of biomass/coal blends in practical systems.

(To request email library@energylibrary.org.nz and quote **Bio5-Behdad**)

Fuel quality changes during seasonal storage of compacted logging residues and young trees. M. Pettersson and T. Nordfjella. *Biomass and Bioenergy*; Volume 31, Issue 11-12, November 2007, p.782-792

Forest fuel procurement creates logistical problems, as large stocks are accumulated along the supply chain. The purpose of this study was to examine fuel quality (moisture content, ash content and calorific value) of compacted young trees (mainly downy birch) and both uncompacted and compacted logging residues (LR) (mainly Norway spruce). The materials were examined before and after storage, with and without cover, and effects of handling were considered. Dry matter losses from compacted LR during storage and handling were determined. Fuel quality and mass were determined before and after storage and handling. The moisture content of LR dropped to 28.6% when stored in small piles after fuel adapted logging at the clear felling site for 3 weeks in May. Drying continued after compaction into cylindrical bales (length 3.4 m, diameter 0.7 m) and during storage in windrows (9 and 12 months), the moisture content falling to 18.2–20.7% for the covered and 18.8–24.9% for the uncovered material. The windrow of loose LR remoistened to 40.8% (by snow contamination) resulted in a 6% lower net calorific value as received, compared to cylindrical bales. Ash contents were in the range 1.6–2.2% for LR and 1.0–1.2% for young trees. Dry matter losses ranged from 8.4% to 18.1% on compacted LR. Remoistening during the winter is higher for loose than for compacted LR. Early summer in northern Sweden provides favourable conditions for drying forest fuels.

(To request email library@energylibrary.org.nz and quote **Bio5-Pettersson**)

Pyrolysis kinetics of lignocellulosic materials—three independent reactions model. J. J. M. Orfão et al. *Fuel*; Volume 78, Issue 3, February 1999, p.349-358

The behaviour of biomass components (cellulose, xylan—representative of hemicelluloses—and lignin) was studied thermogravimetrically with linear temperature programming, under nitrogen and air. The results were compared and the pyrolysis kinetics of cellulose determined, assuming a first-order kinetic function. The thermal decomposition of xylan and lignin could not be modelled with acceptable errors by

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means of simple reactions. Thermograms were determined for pine and eucalyptus woods and pine bark, under inert (nitrogen) or oxidizing (air) atmosphere. The pyrolysis of these lignocellulosic materials was modelled with good approximation by three first-order independent reactions. One of these reactions is associated with the primary pyrolysis of cellulose, its parameters being previously determined and fixed in the model. The model parameters are the activation energies and pre-exponential factors for the pyrolysis of the remaining two pseudo-components and two additional parameters related to the biomass composition. A method to determine this composition was proposed. The results calculated in this way were compared with data from the literature and those determined thermogravimetrically in air, showing good agreement.

(To request email library@energylibrary.org.nz and quote **Bio5-Orfao**)

Ethanol from cellulose: A general review. Badger, P.C. (2002). In: J. Janick and A. Whipkey (Eds.). Trends in new crops and new uses (p.17-21). Alexandria, VA., ASHS Press.

(To request email library@energylibrary.org.nz and quote **Bio5-Badger**)

Pyrolysis and combustion characteristics of biomass and waste-derived feedstock. Skodras, G. et al. *Industrial and Engineering Chemistry Research*; 45 (11) 2006, p.3791-3799

Dicusses research done on the pyrolysis and combustion behaviour of ten various biomass and waste materials, which included olive kernels, willow, forest residue and MBM (meat and bone meal).

(To request email library@energylibrary.org.nz and quote **Bio5-Skodras**)

CFB air-blown flash pyrolysis. Part I: Engineering design and cold model performance. Boukis, I.Ph. et al. *Fuel*; Volume 86, Issues 10-11, July-August 2007, p.1372-1386

The objective of this work was to design, construct and test a novel circulating fluid bed fast pyrolysis reactor system for production of liquids from biomass. The novelty lies in incorporating an integral char combustor to provide autothermal operation of the reactor. A reactor design methodology was devised which correlated input parameters to process variables, namely temperature, heat transfer and gas/vapor residence time, for both the char combustor and biomass pyrolyser. From this methodology, a CFB reactor was designed with integral char combustion for 10 kg/h biomass throughput. A full-scale cold model of the CFB unit was developed and tested to derive suitable hydrodynamic relationships and performance constraints. The hot CFB reactor was constructed, its operability was tested and appropriate modifications were accomplished prior to the commissioning. A major requirement for the desired dual-mode operation of the reactor system conceived was the close coupling of the two reactor subsystems, namely the pyrolysis riser (medium temperature) and char combustor (high temperature). The basic CFB reactor design was proven effective in providing the high heat transfer rates – expressed as low voidage values in the riser and high solid circulation rates – to biomass particles in the very short vapor residence times (VRTs) required. The understanding of the complicated aspects related to two-phase gas–solids flow in the standpipe resulted in a smooth, stable transfer of solids over a wide range of operating parameters during cold CFB reactor operation. In the hot CFB unit testing, the use of two and three cyclones in series was proved insufficient to capture char and unconverted wood particles, especially during the reactor start-up phase. These problems were partially faced by adopting a configuration of a primary cyclone and inertia impinger in series, but further

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development is still required. A variety of configurations for the product collection system were built and tested, the most efficient being a combination of a shell-and-tube heat exchanger (condenser) and a cotton wool filter. However, the liquid recovery configuration gave rise to a number of problems, the most important being gradual plugging of the heat exchanger due to the formation of sticky solid-liquid agglomerates.

(To request email library@energylibrary.org.nz and quote **Bio5-Boukis**)

Residential combustion performance of pelletized hydrolysis residues from lignocellulosic ethanol production. Öhman, M. et al. *Energy and Fuels*; Vol. 20, No. 3: May 2006 p.1298-1304

(To request email library@energylibrary.org.nz and quote **Bio5-Ohman**)

The study of reactions influencing the biomass steam gasification process. C. Franco et al. *Fuel*; Volume 82, Issue 7, May 2003, p.835-842

Steam gasification studies were carried out in an atmospheric fluidised bed. The gasifier was operated over a temperature range of 700–900 °C whilst varying a steam/biomass ratio from 0.4 to 0.85 w/w. Three types of forestry biomass were studied: *Pinus pinaster* (softwood), *Eucalyptus globulus* and holm-oak (hardwood). The energy conversion, gas composition, higher heating value and gas yields were determined and correlated with temperature, steam/biomass ratio, and species of biomass used. The results obtained seemed to suggest that the operating conditions were optimised for a gasification temperature around 830 °C and a steam/biomass ratio of 0.6–0.7 w/w, because a gas richer in hydrogen and poorer in hydrocarbons and tars was produced. These conditions also favoured greater energy and carbon conversions, as well the gas yield. The main objective of the present work was to determine what reactions were dominant within the operation limits of experimental parameters studied and what was the effect of biomass type on the gasification process. As biomass wastes usually have a problem of availability because of seasonal variations, this work analysed the possibility of replacing one biomass species by another, without altering the gas quality obtained.

(To request email library@energylibrary.org.nz and quote **Bio5-Franco**)

Energy efficient production of hydrogen and syngas from biomass: Development of low-temperature catalytic process for cellulose gasification.

Mohammad Asadullah et al. *Environmental Science & Technology*; Vol. 36, No. 20: October 15, 2002, p.4476 – 4481

(To request email library@energylibrary.org.nz and quote **Bio5-Asadullah**) ✓

Effect of cellulose and lignin content on pyrolysis and combustion characteristics for several types of biomass. Asri Gani and Ichiro Naruse. *Renewable Energy*; Volume 32, Issue 4, April 2007, p.649-661

Fundamental pyrolysis and combustion behaviors for several types of biomass are tested by a thermo-gravimetric analyzer. The main compositions of cellulose and lignin contents for several types of biomass are analyzed chemically. Based on the main composition results obtained, the experimental results for the actual biomass samples are compared with those for the simulated biomass, which is made of the mixture of the cellulose with lignin chemical. The morphological changes before and after the reactions are also observed by a scanning electron microscope. The main compositions in the biomass consisted of cellulose and lignin. The cellulose content was more than lignin for the biomass samples selected in this study. The reaction for the actual

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biomass samples proceeded with the two stages. The first and second stage corresponded to devolatilization and char combustion during combustion, respectively. The first stage showed rapid mass decrease caused by cellulose decomposition. At the second stage, lignin decomposed for pyrolysis and its char burned for combustion. For the biomass with higher cellulose content, the pyrolysis rate became faster. While, the biomass with higher lignin content gave slower pyrolysis rate. The cellulose and lignin content in the biomasses was one of the important parameters to evaluate the pyrolysis characteristics. The combustion characteristics for the actual biomass depends on the char morphology produced.

(To request email library@energylibrary.org.nz and quote **Bio5-Gani**)

Biomass gasification in a 100kW fast internal circulating fluidised bed gasifier. Brown, J.W. et al. *NZ Journal of Forestry*; 51(2) 2006: p.19-22

(To request email library@energylibrary.org.nz and quote **Bio5-Brown**)

Power generation potential of biomass gasification systems. Charles M. Kinoshita et al. *Journal of Energy Engineering*; Vol. 123 (3) Dec 1997, p.88-99

Biomass has the potential to contribute a significant portion of the electricity consumed in industrialized nations and a major share of the power mix in developing countries. In addition to providing an alternative to fossil-fuel-based energy and creating new markets for agriculture, a renewable resource like biomass used in a sustainable fashion facilitates closure of the carbon cycle. To realize these benefits, particularly in the shadow of uncertainties cast by deregulation and recent changes in federal energy and agricultural policies, biomass power systems must be competitive with incumbent power-generation technologies in terms of generation efficiency and overall cost. Anticipated performance and cost of biomass-based integrated gasification, combined-cycle power systems are discussed. The electric power that can be generated worldwide using existing biomass resources (primarily crop residues and wastes) and the potential amount that could be generated from crops grown specifically for electricity generation are projected. Technical and economic obstacles that must be overcome before advanced biomass-power systems based on aeroderivative turbines or fuel cells can become fully commercial are identified. Research, development, and demonstration efforts under way or being planned to overcome those obstacles are described; developments in a major biomass gasification demonstration project taking place in Hawaii under the auspices of the U.S. Department of Energy and the State of Hawaii are detailed.

(To request email library@energylibrary.org.nz and quote **Bio5-Charles**) ✓

Renewable fuels and chemicals by thermal processing of biomass. A. V. Bridgwater. *Chemical Engineering Journal*; Vol. 91, (2-3), 15 March 2003, p.87-102

Bio-energy is now accepted as having the potential to provide the major part of the projected renewable energy provisions of the future. There are three main routes to providing these bio-fuels—biological conversion, physical conversion and thermal conversion—all of which employ a range of chemical reactors configurations and designs. This review concentrates on thermal conversion processes and particularly the reactors that have been developed to provide the necessary conditions to optimise performance. A number of primary and secondary products can be derived as gas, liquid and solid fuels and electricity as well as a considerable number of chemicals. The basic conversion processes are summarised with their products and the main technical and non-technical barriers to implementation are identified.

(To request email library@energylibrary.org.nz and quote **Bio5-Bridgwater**)

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Progress in biomass gasification: An overview. Maniatis, K. (2001). In A.V. Bridgwater (Ed). Progress in Thermochemical Biomass Conversion, Vol. 1 p1-31. Blackwell Science Ltd.
(To request email library@energylibrary.org.nz and quote **Bio5-Maniatis**)

Papers of interest from a recent addition to the Energy Library bioenergy collection.

The articles listed below are all from the book, "Science in thermal and chemical biomass conversion" (2006). Volumes 1 and 2. Bridgwater, A.V. and Boocock, D.G.B. Speen: CPL Press

Combustion

Effects of particle shape and size on biomass reactivity. Lu, H. et al. V1 p.117-134
(To request email library@energylibrary.org.nz and quote **Bio5-Volume1a**) ✓

Low particle furnace for wood pellets based on advanced staged combustion. Oser, M. and Nussbaumer, T. V1 p.215-227
(To request email library@energylibrary.org.nz and quote **Bio5-Volume1b**) ✓

The dynamics of grate combustion systems: Modelling and validation. Van Kessel, L.B.M. and Brem, G. V1 p.237-251
(To request email library@energylibrary.org.nz and quote **Bio5-Volume1c**) ✓

Biomass fly ash in concrete. Wang, S. et al. V1 p.325-330
(To request email library@energylibrary.org.nz and quote **Bio5-Volume1d**) ✓

Feed Preparation

BIOCA - biomass streams to produce cellulose acetate. Harrison, I. et al. V1 p.370-381
(To request email library@energylibrary.org.nz and quote **Bio5-Volume1e**) ✓

Biodiesel

Synthesis, characterization and applications of vegetable oil derived esters as diesel additive. Dalai, A.K. V1 p.413-423
(To request email library@energylibrary.org.nz and quote **Bio5Volume1f**) ✓

Gasification Processes

Gasification of urban biomass (i.e. sorted MSW: essentially biomass, plastics and inorganics) Gagnon, M. et al. V1 p.734-353
(To request email library@energylibrary.org.nz and quote **Bio5-Volume1g**) ✓

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Gasification Products

Scale-up of a reactive adsorption process for the purification of biogas produced by psychrophilic anaerobic fermentation of swine manure biomass.

Abatzoglou, N. and Truong LV-A. V1 p.847-857

(To request email library@energylibrary.org.nz and quote **Bio5-Volume1h**) ✓

Operation and techno-economics of a Capstone micro-turbine operated on downdraft gasifier producer gas. Peacocke G.V.C. et al. V1 p.908-921

(To request email library@energylibrary.org.nz and quote **Bio5-Volume1i**) ✓

Hydrothermal and Supercritical

Decomposition behavior of lignocellulosics by supercritical water treatment and its process for their efficient use. Ehara, K. and Saka, S. V2 p.1046-1058

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2a**) ✓

Evaluation of thermochemical liquidization and anaerobic digestion for food waste management system based on GHG emission. Tsukahara, K. et al. V2 p.1099-1103

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2b**) ✓

Pyrolysis Processes

Experiments on the pyrolysis of biomass. Schroder, E. V2 p.1304-1316

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2c**) ✓

Analysis of the process conditions for fast pyrolysis. Wang, X. et al. V2 p.1308-1390

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2d**) ✓

Pyrolysis Products

The black gold from green waste project at the University of Hawaii. Nunoura, T. and Antal, M.J. V2 p.1602-1613

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2e**) ✓

Systems

Renewable transportation fuels from biomass and black liquor. Hunsaker, M. et al. V2 p.1683-1699

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2f**) ✓

Competitiveness and CO2 mitigation costs of biogenic residues and waste for heat and power production. Leible, L. et al V2 p.1727-1739

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2g**) ✓

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Biomass Japan strategy. Yokoyama,S. et al. V2 p.1837-1699

(To request email library@energylibrary.org.nz and quote **Bio5-Volume2h**) ✓

Conference Papers

Combustion of wood processing residues in a circulating fluidized bed.

Fernando Preto. 17th International Fluidized Bed Combustion Conference. May 2003, Jacksonville, Florida USA. FBC2003-171. *Proceedings of the International Conference on Fluidized Bed Combustion*; p.607-612

(To request email library@energylibrary.org.nz and quote **Bio5-Preto**)

Intermediate scale ethanol production. (1980) Kirby, K.D., Mardon, C.J. *Fuel Ethanol R&D Workshop*; Canberra

(To request email library@energylibrary.org.nz and quote **Bio5-Kirby**)

Progress in the commercialization of lignocellulosics-to-ethanol. Saddler, J.N. et al. Paper presented at the 2nd World Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection. Rome, Italy, May 2004

(To request email library@energylibrary.org.nz and quote **Bio5-Saddler**)

Demonstration of new gasification technology. (2004) Patel, J. and Salo, K. In *Proceedings of the Second World Biomass Conference, Biomass for Energy, Industry and Climate Protection held in Rome, Italy, 10-14 May 2004*. Vol. 1 p.44-47

(To request email library@energylibrary.org.nz and quote **Bio5-Patel**)

Reports

The forest biorefinery environmental footprint (2007) *NCASI Special Report (07-05)*, p.1-30

(To request email library@energylibrary.org.nz and quote **Bio5-Footprint**)

Status of gasification in countries participating in the IEA & GasNet activity.

(2004). This report is available [online](#).

Lignocellulosic biomass to ethanol process design and economics utilizing co-current dilute acidprehydrolysis and enzymatic hydrolysis current and futuristic scenarios. (1999). This report is available [online](#).

Conference

Bioenergy Forum 2008: Fuelling the Growth & Sustainability of Biofuels in Asia. 28 – 30 April 2008, Swissotel Nai Lert Park Bangkok, Thailand

For more information visit the forum [website](#).

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Web links

Forest floor full of energy – NZ Herald [news](#) 17/03/2008

NZ Biofuel Manufacturers Association formed – [Press release](#) 13/03/2008

Purpose grown energy forests for self-sufficiency – Scion [press release](#) 18/03/2008

Doing their bit for Earth with fire and water. *The Press*; 13/03/2008. Two Christchurch businessmen have developed a hot tub that uses firewood or liquid petroleum gas and is so efficient that chemicals are not needed. Read article [online](#).

Observations on the current status of biomass gasification. (2005). Paper submitted for publication by Dr Suresh P. Babu, Leader of Task 33: Thermal Gasification of Biomass. This paper is available [online](#).

Heat and power applications of advanced biomass gasifiers in the New Zealand wood industry. Rutherford, J.P., Williamson, C.J. (2006) Auckland, New Zealand: CHEMECA 2006, 17-20 Sep 2006. Conference Proceedings of CHEMECA 2006: Knowledge and Innovation, 6p. This paper is available [online](#) and J. Rutherford's related Masters thesis is available [here](#) (pdf).

Focus on biomass gasification. *FIB Bioenergy Research newsletter*; Issue 20 (June 2007). Topics in this issue include:

- The largest gasification plant in Europe
- Natural gas is out – wood gas is in
- Remove the stench - add an alga to your tank

Access the newsletter [here](#) (pdf) or via this [webpage](#).

A novel biomass air gasification process for producing tar-free higher heating value fuel gas. Yan Cao et al. *Fuel Processing Technology*; Volume 87, Issue 4, April 2006, p.343-353. This article is available online [here](#) (pdf) or via [here](#).

Bioenergy lists: Gasification. This [webpage](#) listing bioenergy resources was created to help people involved in the development of gasification systems.

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