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Roadmap 2030 for the Dutch glass industry

Jaap van der Woude* gives an update on the Technology Roadmap 2030 for the glass industry in The Netherlands. The roadmap sets out a plan for the development and application of measures to obtain cost effective solutions imparting clean or low emissions.

With 24 melting furnaces at nine locations, The Netherlands' glass industry is both diverse and significant on a per capita basis. Glass products produced there include: Packaging, flat, wool, fibres, table and speciality glass such as lighting (***Fig 1***). All major Dutch glass manufacturers are owned by global groups. *The Long Term Agreement on Energy Efficiency*, signed by the Dutch glass industry and the Dutch government in 2009 (the so-called MEE agreement) asks whether a 50% energy efficiency improvement in making a glass product involving the production chain is feasible. This question did exclude the benefits society sees through the use of glass for its insulation effectiveness in buildings or use as a lightweight reinforcement material for composites.

The Dutch glass industry achieved an energy efficiency improvement of more than 20% per unit of product in the past 20 years, while meeting strict emission requirements. Dutch glass producers rank among the top when it comes to energy efficient production, recycled content, low emissions, innovation and added value (***Fig 2 & 3***).

The driving force was high energy cost. These achievements have also been fuelled by cooperation in pre-competitive research among the glass producers and TNO Glass (now Celsian Glass and Solar), supported by AgentschapNL (formerly Senter Novem), a government agency that stimulates energy improvement in industry.

This cooperation contributed to the early introduction of a batch pre-heating unit using flue gases from the furnace, technology for several oxygen-fired glass furnaces, development of process control software, high level of glass recycling and model-based furnace control. These process-integrated measures have contributed to NO_x, SO_x and particulate matter reductions. The cooperation also maintained a focus on training and education through the development and updates of a glass handbook and technology training courses.

The next steps for a reduction of energy use - on a broader basis of the value chain (material supply and logistics, but not including service life savings), will necessitate combinations of evolutionary and revolutionary measures while maintaining an economically viable basis for the glass industry. This is critical as glass furnaces are today so efficient: Glassmaking has become close to the thermodynamic minimum (***Fig 4***).

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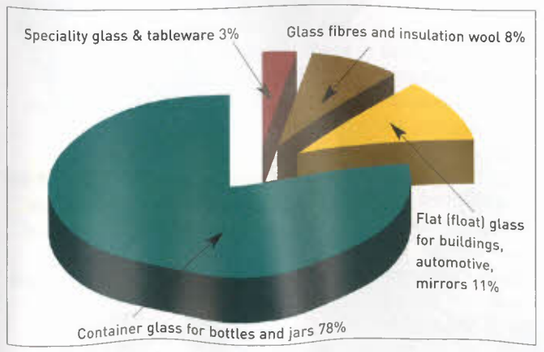
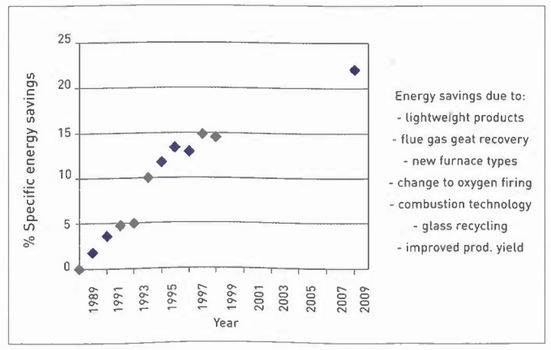
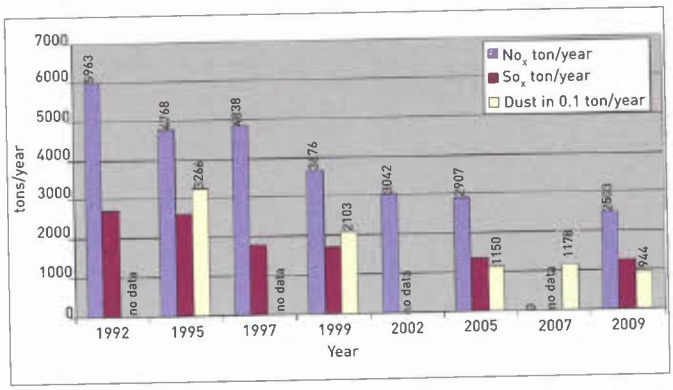


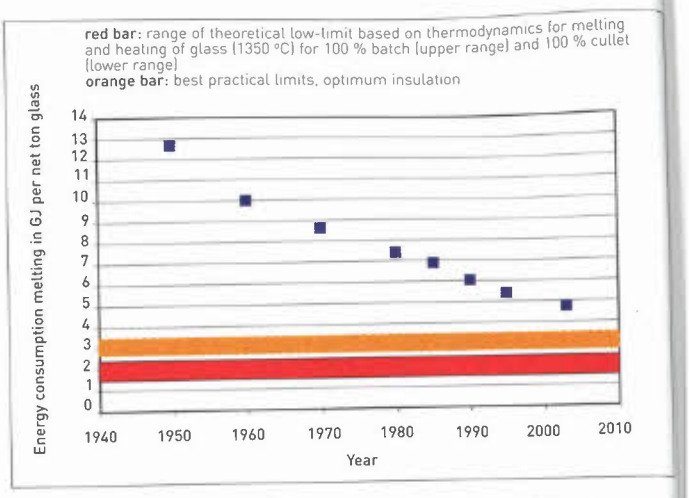
▲ Fig 1. Glass production in The Netherlands (1.260.000 tonnes per year).



▲ Fig 2. Estimated specific energy savings in the Dutch glass industry 1989-2009.



▲ Fig 3. Dust, NO_x and SO_2 emissions of NL glass industry in 1992-2009 period.



▶ Fig 4. Specific energy consumption NL container glass furnaces.

Roadmap 2030

The Roadmap 2030 project was preceded by a feasibility pre-study, executed by most of the sector in 2010. Six companies with nine production plants were involved.

Dilemmas included the question of a sufficient common basis for pre-competitive cooperation, investment and pay-back time, competitor issues, the fact that all companies have international 'mothers' with their own strategies as to product and process technology as well as investment strategies. Financial resources for pre-competitive R&D were also limited.

The pre-study identified five focus areas:

- Optimisation of production processes
- Improving product performance
- Strengthening sustainability of the product chain
- Improve the image of glass/products
- Improve innovative power

Due to market diversity and competition, the improvement of product performance was left to the individual companies.

As to the image of glass products this subject was deferred to the various branch organisations and to a larger industry forum to support manufacturing activities as a whole. The pre-study defined the key aspects for further review and main directions for innovation. This required outside expertise (mainly from Celsian Glass and Solar) on glass technology and R&D developments for which AgencyNL provided additional financial support.

The roadmap project itself was supervised by the board of the branch organisation for Glass in The Netherlands and executed under the guidance of an industry based project team supported and coordinated by AgencyNL and ATOS consultants.

Measures and development

As a result of the study actions were undertaken to achieve energy efficiency improvement (***Fig 5***).

The identified areas are:

Optimisation of production processes:

- Energy recovery from waste heat
- Process Control of melting process
- Optimisation of glass composition
- Optimisation of raw material and new raw materials
- Optimisation of forming processes
- New furnace designs: more energy efficient, productive

Strengthened sustainability:

- Focus on level and quality of recycling material

Improving innovative power:

- Improving educational opportunities
- Maintain know-how & skills
- Develop opportunities for demonstration projects
- International approach & cooperation

A thorough analysis, including global initiatives in these areas, was conducted on options and measures for innovation. A preference exists for measures that are energy, process and cost-efficient and can realise emission reductions.

Many measures can only be fitted and synchronised to the rebuild cycle of furnaces, which will bear fruit in the future as furnace life can be 15 to 20 years.

Also essential is to maintain strong technical institutes at home and abroad allowing 'translation' of new developments into practical solutions as well as international cooperation.

While developing the roadmap, recent developments in the field of education were taken into account. Short term, this has to ensure the link between vocational education and demand-based competences in addition to the professional technical glass courses.

Next to securing existing knowledge, the sector will devote itself to accelerating the development of new knowledge. In cooperation with CelSian and AgencyNL, theme-based meetings and workshops will be organised to facilitate this. Academic chairs in glass technology to educate students as engineers and glass technologists, as well as connecting the industry with (international) research programmes will be essential for a national and internationally viable glass industry.

Priorities and execution

The Roadmap identified fields of interest. Industry has identified priorities for execution. ***Table 1*** shows a selection of initiatives for the three focus areas. The initiatives in red represent external and/or internationa cooperation. Details on the various subjects can be found in the Roadmap ('routekaart') link.http://www.agentschapnl.nl/search/apachesolr_search/routekaart%20glasindustrie

- 1. Hyperspectral Imaging: Identification of ceramics and glass ceramics in cullet streams
- 2. TCR = Thermo Chemical Recuperator to recover 50-70% of th flue gas energy by synthesising hot reformer gas as energy efficient fuel.
- 3. rMPC: Advanced model based process control for glass melting & combustion processes

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- 4. HPO furnace: Next generation intensive oxygen-fired glass melter
- 5. GT feeder: Improved feeder concept
- 6. CO-sensor for combustion control in glass furnaces

In ***Table 1*** it is important to note that the subjects are a mixture of evolutionary and revolutionary (typically red) developments. The former can be judged on what technology is available today and what is under development for practical use and can be implemented short and mid term. The latter require breakthroughs. Broad international initiatives, such as Glass Trend projects, are required, and a lot of work to transform from concept to practical implementation. Risks are high, as are the development costs.

What can be done?

With today's knowledge, assuming that investments are affordable, a questionnaire was developed. The results are in ***Table 2*** as a percentage specific energy saving compared to 2009 in the glass industry in The Netherlands.

Important contributions came from lighter container glass articles, latest developments in furnace design and process intensification and progressive use of technologies for the re-use of waste heat. More recycling and use of selected alternative raw materials were also contributors. It goes without saying that the implementation of the latest efficiency standards in today's furnaces as well as productivity improvement from these assets has to be synchronised with the rebuild schedules of furnaces. Given the longer furnace life, it will happen during the planning period.

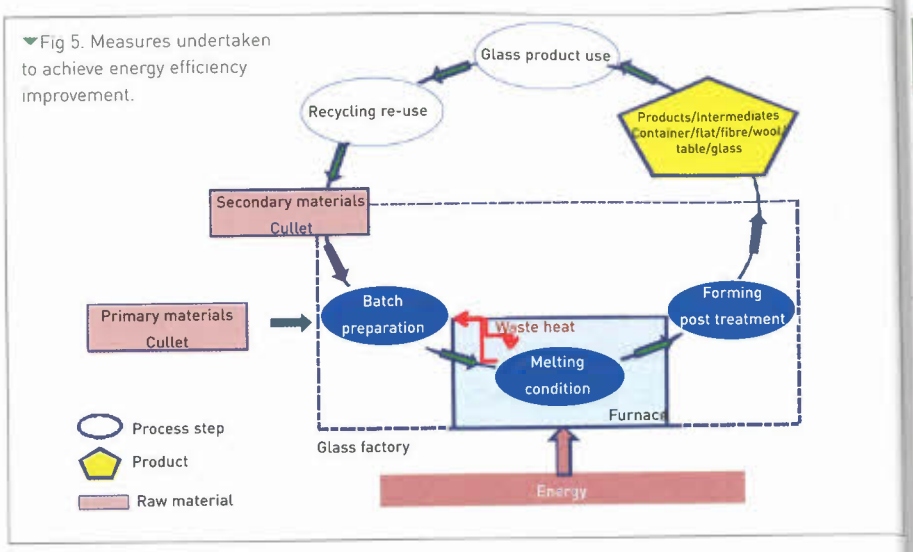

Fig 5. Measures undertaken to achieve energy efficiency improvement.

Progress tracking

The voluntary agreement requires an annual monitoring procedure on energy consumption and implementation of measures. A per plant based Energy Efficiency Plan (EEP) to be renewed regularly, forms the basis for longer term planning per company.

The results are reviewed annually by the VNG Board and the Ministry of Economic Affairs, Agriculture and Innovation. A key area is consistency of applying monitoring methodologies, which is complicated by the fact that many different energy carriers are used within the industry. Other aspects such as energy savings in raw material supply and glass product performance also need attention. This is still a work in progress.

Conclusion

The Roadmap for the Glass Industry in The Netherlands is proof that among a variety of glass industry sectors, a long-term pre-competitive programme can be agreed that targets a clean, resource effective and potentially profitable glass industry for 2030. Although the challenge of 50% energy efficiency improvement including certain value chain aspects based on today's know how does not seem achievable, a 25% improvement may be possible depending on finances. The improvement is based on current insights and knowledge and revolves around furnace design and productivity, implementation of waste heat recovery and selective batch raw materials. Investments can only be justified provided an integrated approach is followed. A strengthened educational basis as well as an international network between national and international knowledge institutes will be essential.

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Improving innovative power	Strengthening sustainability Increase use of cullet	Optimisation of production processes
Website	Hyperspectral imaging[1]	Glass trend, innovation contracts: Join or invite other industry segments to participate (ISPT,...)
Know how transfer: Workshops	Green deal SDV	TCR[2]
Expand training capabilities: Develop low and mid level courses	Green deal VRN	Thermodynamic modeling of glass
Academic chair		Redox sensor
Activities companies Libbey, Ardagh, OI		rMPC[3]
Committee education and labour market		HPO furnace[4]; GT feeder[5] Novel furnace designs Alternative batching processes

▲ Table 1. Initiatives for the three focus areas

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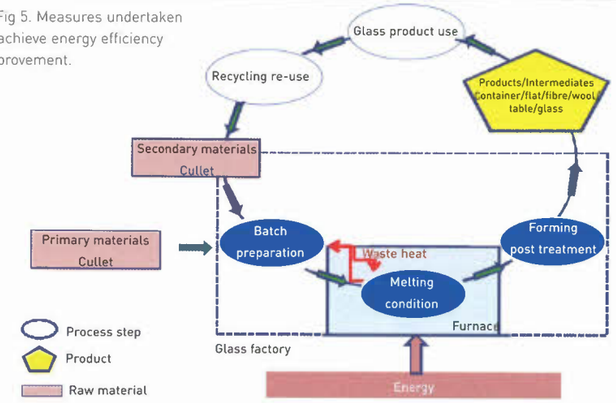

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	Supply chain	% EE t improvement
Raw materials		
Alternatives for primary RM	Replacement of RM	0.2
Increase secondary RM	More recycling	1.4
Products		
Improved characteristics	Lighter (container)	3.5
Glass composition (lighter, stronger)	Products save energy in use	Not quantified
Process		
Alternatives for primary RM	Alternative RM	1.4
Innovations batch preparation	Batch pre-treatment	>0.1
Innovations in furnace design/	Furnace design	7.8
intensification	Revisions, processing	3.8
Innovative process control	Sensoring, model based control	1.2
New methods re-use waste heat	Energy from waste heat	5.6
Forming and processing	a.o. more efficient cooling, drying	0.3
Total		**25.2**

Table 2. Energy efficiency improvement 2030 v 2009 (12500 TJ/year)

Another boundary condition, although not discussed in any detail, will require acceptable investment conditions for industry in Western Europe and a level playing field for the glass industry there.

Execution will require an R&D focus on available expertise in specific areas, cooperation with suppliers, research institutes, other glass producers as well as a positive attitude from the relevant authorities towards industry.

National and international cooperation should be sought after and R&D capacities maximally joined.

To realise further energy efficiencies beyond a 20-25% improvement, breakthrough technologies are required, which by definition will be a longer-term target with global cooperation.

Finally, the life cycle gains of glass products, i.e their energy saving performance during their lifetime, are much more than significant and were not included in this study but it can be stated that most glass products are essential for a sustainable future. ■

Acknowledgement

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