

UNPRECEDENTED HEAT PUMP MARKET DEVELOPMENT IN NORWAY: WHAT HAPPENED, AND WILL IT LAST?"

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ABSTRACT

The Norwegian heat pump market "exploded" in 2003, and sales reached an all-time high of 55,100 units (all types included). For comparison, the normal figure during the 1990s was between 1,000 and 2,000 units annually. This paper discusses the reasons behind the unprecedented market development. Several factors seem to explain the peak. One is the introduction of an *investment subsidy scheme*, which was launched as an immediate action from the government in response to the extreme electricity prices during the first quarter of 2003. Preliminary results from an evaluation of this scheme are presented. Other factors, which have contributed to the record sales figures, are: the extreme peaks in electricity prices, systematic market efforts over years undertaken by different actors, the massive media attention, the increased market competition yielding lower equipment prices, and the improved product quality over time. The paper also discusses the long-term trends and future prospects of heat pumps in Norway. With expected sales in 2004 between 20-25,000 units (comparable to 2002), the market is still relatively hot.

Key Words: *heat pumps, market development, sales figures, investment subsidy scheme, Norway*

1 INTRODUCTION

During the 1990s, annual heat pump sales in Norway were in the range of 1,000 to 2,000 units, and heat pumps were continuously regarded as "the promising technology." In 2003, however, 55,100 units were sold. Compared to sales figures in the large heat pump countries, the absolute numbers are still relatively modest. However, the rapid increase on a percentage basis is quite unique, even at the international level. This paper takes a look behind the figures, and tries to find explanations for the boom.

Roughly 95 % of units sold in 2003 were air-to-air, split type heat pumps in the 3 to 10 kW capacity range. This percentage is also relatively correct in terms of the total number installed in Norway. This paper's discussion is by and large centered on this type.

2 BACKGROUND

During the post World War II period and up until the end of the last century, Norwegian electricity prices have been very low compared to other countries. The reason behind was abundance of hydro-generated power and a government determination to keep the prices low through market regulation. An advantage for homeowners was stable and predictable prices. The result of this market regulation was a continuous shift towards the use of electric baseboard heaters, which were cheap to buy and cheap to use.

2.1 The New Energy Act of 1991

In 1991, the government introduced the New Energy Act. A key intention with this Act was to deregulate and liberalize the electricity market. As a result, electricity prices were now to be set by market factors, such as supply and demand. For the first decade, however, prices remained relatively stable. Figure 1 shows weighted average prices to households – i.e. the net price the households pay, which consist of the electricity price (blue), cost of transmission (red), and all taxes (yellow). The exception was a small peak in 1997 resulting from dry weather and lower than normal production of hydropower.

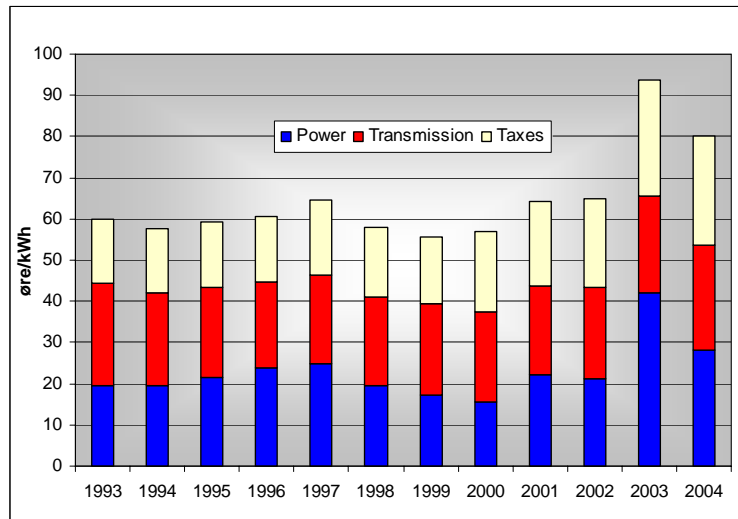


Fig. 1. Development in net average electricity prices to households in Norway 1993-2004 [SSB and NVE].

Another way of illustrating the price fluctuations is the *spot market prices* for the electricity, only. Figure 2 shows the monthly variations [Nordpool]. It should be noted that even average monthly variations in many instances do not reflect the extreme peaks that occurred during the first quarter of 2003.

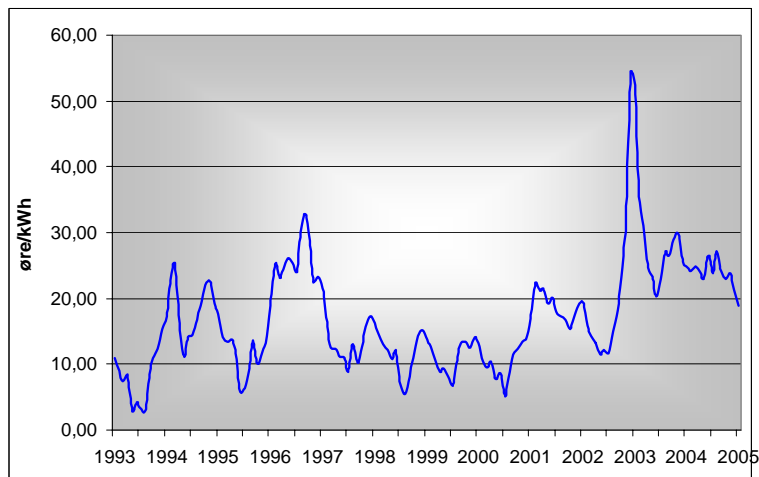


Fig. 2. Monthly variations in electricity price only. Period 1993-2004. Transmission costs and taxes are not included [Nordpool]

It should also be mentioned that in 1996, Norway and Sweden entered into joint market cooperation, as a first step towards a common Nordic electricity market. It is not believed that this event had any significant influence on prices.

2.2 Electricity Dependence and a Dry Winter

The turning point came during the winter of 2002/2003. A very dry 2002 fall and 2003 winter with far less than normal precipitation for the country as a whole, made electricity prices to homeowners skyrocket. For shorter periods of time the price was around NOK 1.50 per kWh, an increase of roughly 250 % compared to the pre-2003 level.

For Norwegians, most of whom had become quite dependent on electricity for heating purposes, this was a totally new situation. Many were not able to pay their electricity bill. Others turned down the indoor temperature to levels far too low to maintain a sound living. Needless to say, this situation was discussed in newspapers almost daily during the winter, and radio and television ran discussion programs on the theme several times a week. There was also a lot of aggression in the debates against politicians and energy utilities. This was based on the fact that there had been a substantial export of electricity in a situation where it early during the year became clear the Norway would not even be self-sufficient. In any case, the important issue of rational use of energy had become a hot topic also in Norway. Table 1 provides some facts about the Norwegian residential sector.

Table 1. Facts about the Norwegian residential sector

- 1.1 million single family houses
- 400,000 terrace houses and small condominiums
- 500,000 flats
- Living area has increased from 36m² in 1980 to 52m² in 2001
- 80% own their own house
- Each single family house uses on average 27,500 kWh annually
- More than 80% of the houses use direct electric heating, about 40% use only direct electric heating
- In 1995, only 1% of houses constructed had hydronic heating system. In 2003 about 40% of new houses were equipped with hydronic heating systems

The psychology behind electricity prices to Norwegians can be compared with that of gasoline prices to Americans. The argument is that prices should stay cheap because electricity is a commodity we are so dependent on. At the same time the general price level in Norway is among the highest in the world.

2.3 The Government Must Act

The Ministry of Petroleum and Energy was put under an immense pressure to act in order to alleviate the situation for people with economic problems as a result of the high electricity prices. As one of several responses, the Ministry introduced an investment subsidy scheme called the *Household Support Scheme*, and the intention was implementation of energy efficient technologies. Administered by Enova SF, the scheme covered: energy saving control units for electric heaters, pellet stoves, and heat pumps.

The homeowner was eligible for a 20 % investment subsidy, or a maximum of NOK 5,000 rebate. The government allocated a total of NOK 50 million (~US\$ 7.1 million) to the program. Due to an overwhelming response from home owners during the first few weeks of the support scheme, another NOK 25 million was allocated to the program, together with a possibility for Enova to exceed the budget with NOK 150 million. The total available funding was therefore NOK 225 million (~US\$ 32 million).

3 A HEAT PUMP “KLONDIKE”

The overall situation with significantly increased electricity prices and the introduction of the *Household Support Scheme*, together with the fact that heat pumps over the prior years had been “made known” to the public, created a tremendous interest in heat pumps.

The result of the boom, in terms of sales figures, can be seen from Fig. 3. During 2003 the total sales passed 55.000 units, a tremendous increase compared to the pre-2000 level, when the normal annual sales figures were in the range of 1,000-2,000 units. It is important to keep in mind that roughly 95 % of the total sales figures were air-to-air, split type heat pumps, of which basically all were of the reversible type.

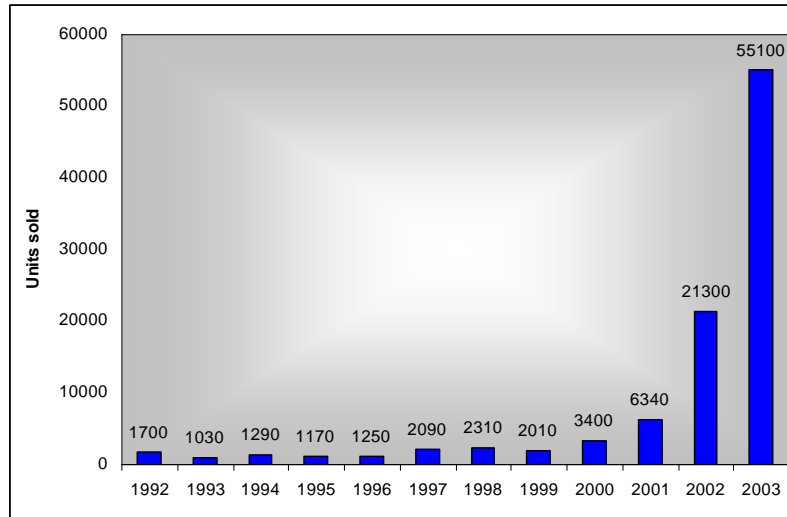


Fig. 3. Norwegian heat pump sales during the period 1992-2003 [NOVAP, 2004].

Market figures for 2004 are not yet available, but indications are that sales figures last year will end up between 20,000 and 25,000 units, and are thus back at the 2002-level.

4 THE HOUSEHOLD SUPPORT SCHEME

The support scheme was introduced primo January 2003, and was open for applications from February 1 through March 15. Due to the very short time from the idea was launched to implementation, Enova SF had three weeks to set up a program that would meet the intentions of the Ministry and effectively serve the needs of the market. The following points were considered important for a successful program:

- The program should encourage investments in equipment that would reduce electricity demand in private residences.
- The program should be available for most private homeowners, i.e. there should be few requirements for the household.
- The requirements should be easy to communicate and, above all, possible to control in an efficient way.
- Easy administration and low administration costs were necessary.
- Investments were to be put into action immediately, as a possible electricity shortage was imminent.
- The program should encourage environmentally friendly technologies, with focus on both the Montreal Protocol and the Kyoto Protocol.
- Focus should be on advanced, but still, mature enough technologies that could be installed in residences in large volumes.

Based on criteria above, Enova landed on the following technologies: *heat pumps, pellet stoves, and advanced control systems*

Maximum investment support was set to 20 % of the total investment cost, limited to NOK 5,000. The application form and all communication with homeowners were arranged electronically through Internet. A two-step procedure was decided. The first was an electronic application resulting in a *prequalification of the residence*, and the homeowners received a letter of agreement. The second step was that after the investment was done and the equipment installed, the home owners were reimbursed based on the *letter of agreement* and receipts. Control questionnaires regarding fulfillment of the requirements had to be signed by the homeowners and installers.

As the criteria were environmentally friendly and advanced technologies, Enova had to make quality requirements for all three technologies and for heat pumps in particular, given that HCFC-22 was still on the market and less than a year away from being banned. The following specific requirements were set for heat pumps:

- The working fluid had to be HFC or natural refrigerants.
- The heat pump had to be CE-certified and had to meet all EN-standards.
- Air-to-air heat pump compressors had to be equipped with inverter.
- Air-to-air heat pumps should be adapted to the wet and cold Norwegian climate.
- Heat pump should be installed by a certified installer.
- Enova recommended Eurovent classification (not a requirement).

By the end of the application period, the number of applicants passed a staggering 50,000. Due to the non-binding application procedure, a low implementation rate was expected. Table 2 shows the applications distributed between the different technologies.

Table 2. Key figures for the application process (LOA = Letter of agreement) [Bjørnstad, et. al., 2005]

	Pellets Stove	Advanced Control Systems	Heat Pumps	Total	Total %
Inadequate applications	592	164	2,696	3,452	7.3
LOA^(*) denied (Phase I)	49	6	274	329	0.7
LOA^(*) Denied (Phase II)	94	65	1,344	1,503	3.2
In quarantine	0	2	7	9	0.0
LOA^(*) received, but not used	2,456	1,025	18,696	22,177	47.0
LOA^(*) received and used	1,215	335	18,139	19,689	41.8
Total (%)	4,406 (9.3)	1,597 (3.4)	41,156 (87.3)	47,159	100.0

All together, 47,159 applications were registered, after double household applications, non-private building owners etc. were removed from the original 50,000. A total of 19,689 accepted the investment support and made an installation, giving an implementation rate of 41.8 %. Of the implemented investments, 87.3 % choose to install a heat pump, i.e. a total heat pump installation of 18,139. Through the investment support scheme the households invested approximately NOK 500 million (~US\$ 70 million) in energy efficient technologies, and received a total government support of NOK 83 million (~US\$ 12 million), or 17 % of the total.

5 WHAT HAPPENED? REASONS BEHIND THE MARKET BOOM

Several factors can serve as potential explanations to the unprecedented market boom during 2003. Some of the more plausible factors are discussed below. It is, however, difficult, if not impossible, to rank these factors in terms of importance. Their order of appearance is, therefore, somewhat random.

5.1 High Electricity Prices

Generally, homeowners are not very occupied with saving energy - a completely different matter is saving money. More than likely, the very high electricity prices during the winter of 2003 played an important role behind the heat pump boom. At the most extreme, homeowners paid around 2.5 times (up to NOK 1.50 per kWh) the normal price per kWh. Even though the extreme prices did not last for a very long time, homeowners had now understood that due to the deregulation of the electricity market, there were “no limits” to the electricity prices anymore. The best remedy was, consequently, to invest in more energy efficient heating systems.

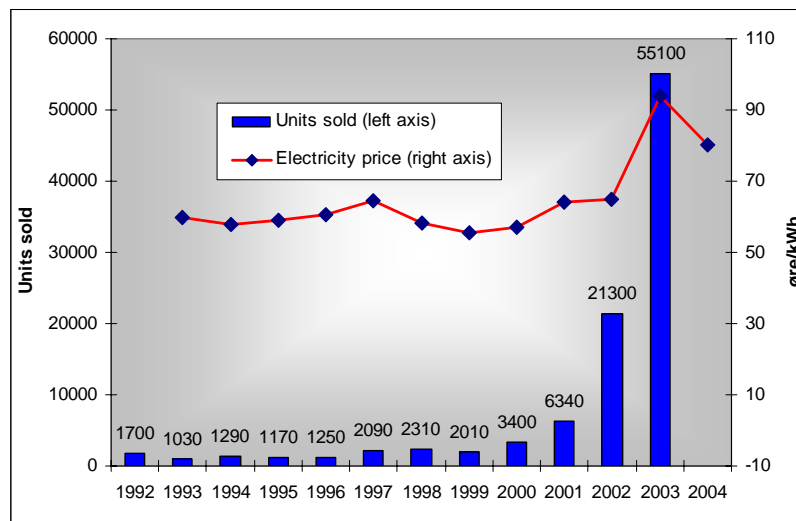


Fig. 4. Electricity prices and heat pump sales.

From Fig. 4 it can be seen that the increase in sales, to a certain extent, coincides with the increase in electricity prices. The price made a jump in 1997 and in 2001, and so did the heat pump sales. The price increased drastically in 2003, and so did the heat pump sales. The exception from the “rule” occurs in 2002 when prices were stable compared to the year before, but heat pump sales tripled. Consequently, other factors do seem to influence the sales.

5.2 The Household Support Scheme

It is also more than likely that the introduction of the government funded *Household Support Scheme* contributed to the high sales figures in 2003. Heat pumps had become a technology “recommended” by the government, and of course, there is nothing like a “free lunch” (or at least having the government pay parts of it). The promotion of the subsidy scheme itself, together with the tremendous media attention, created much positive energy around heat pumps.

However, we see from Fig. 4 that the sales increase started even before the subsidy was introduced. This probably has with the fact to do that much effort, over time, had been put into improving the reputation of heat pumps.

5.3 Systematic Efforts over Long Time

A third reason behind the increasing sales figures for the 2000s is likely the systematic effort by many market actors over several years to build the positive reputation of heat pumps as a reliable and energy saving technology. Especially, the establishment (in 1995) and undertakings of the Norwegian Heat Pump Association (NOVAP) are believed to have had a positive influence. One of NOVAP's main interests has been *education and certification of heat pump sales personnel*, in order to increase the quality of installation. In this respect a tribute should also be paid to the NOVAP member companies, which to a large extent have utilized and participated in the educational programs offered by the association. In this way the companies and its personnel were well prepared when the investment subsidy scheme was launched.

Similarly, the activities undertaken by the regional energy conservation centers (established 1994) and continued by Enova (2001) are believed to have contributed to building a solid heat pump reputation. Typical activities for these organizations have been deployment of neutral and non-biased information, and providing answers to the public on demand, via for instance free telephone hot-lines.

Figure 4 shows that the market roughly doubled from 2000 to 2001, and more than tripled from 2001 to 2002. Part of this is probably related to already increasing electricity prices, but certainly also the fact that heat pumps had become "known" to the public, and the fact that sales agent were now better trained and educated than ever before.

5.4 Increased Media Attention

Increased media attention was also a factor that contributed to the sales increase. Suddenly, heat pumps were all over in all kinds of mass media. Newspapers ran heat pump ads daily and even discussed heat pumps in articles several times a week. Radio and TV had programs on the "energy crisis" several times a week, and heat pumps were often mentioned as a remedy.

Some media attention was also negative. Companies selling electric baseboard heaters voiced their skepticism to the level of potential energy savings with heat pumps. Indoor climate experts attacked the air-to-air heat pumps because of high air distribution temperature and unfavorable air-circulation. Even if the articles were relatively balanced, the headlines were of a kind so the public could become skeptical.

An important reason why heat pumps caught the attention of the media was the direct involvement of the Minister himself. Hardly an interview went by without him mentioning heat pumps as a one of his favorite cures to huge electricity bills.

5.5 Increased Competition and Cheaper Heat Pumps

With increased focus on heat pumps, and prospects of high sales figures, new "heat pump selling companies" mushroomed. The advent of the investment scheme also seemed to bring in many new companies, but in the end most of these companies did not benefit from the scheme, since Enova required that companies had to demonstrate a minimum of heat pump competence. During 2003 the number of importers increased from 20 or 30 to well above 100. Not all of them had any intention of staying long in the market, rather to sell as many units as possible in the shortest amount of time, and then exit the market.

Also, new distribution channels were being applied. Traditionally, heat pumps in Norway have been sold by heat pump or refrigeration contractors, known in general to be competent and serious. Now heat pumps were also offered by department stores, electric stores, and agents even showed up on your doorstep! Furthermore, individuals (not companies) imported containers of heat pumps for sale to friends

and colleagues, either from manufacturers in Asia or from Sweden. Ordering of a “six-pack” of heat pumps from a certain Swedish company allowed for free freight.

The result was, of course, a fierce competition with a significant downward pressure on prices. Before the boom it was difficult buying an air-to-air, split type heat pump for less than NOK 20,000 (~US\$ 3,000), while at the end of the boom prices around NOK 5,000 (~US\$ 700) were not uncommon. It should be noted that the most important factor behind the price reductions was that many new models in the low end of the market with lower quality, were now being offered. The cheapest models were typically on-off units (without the inverter) and sold as do-it-yourself kits.

5.6 Improved Product Quality

Finally, improved efficiency and product quality over time was probably also an important factor behind the sales boost. Back in the early 1990s air-to-air heat pumps used in Norway were typically associated with quick frost formation, inefficient defrosting, and, consequently, poor energy efficiency. With the advent of the inverter technology, more efficient defrosting systems, and the HFC working fluids, earlier disadvantages with the heat pumps were removed, and the general quality perception among the public was significantly improved. Furthermore, the fact that most products were now certified by Eurovent and were equipped with energy labels, also contributed, in the public eye, to higher quality and that heat pumps could now be trusted as reliable and energy saving devices.

6 EVALUATION OF THE HOUSEHOLD SUPPORT SCHEME

After the support scheme was terminated, Enova SF contracted out an independent evaluation of the scheme. Since the final report [Bjørnstad, et. al., 2005] is not yet available, the main findings are listed below in bullet form.

6.1 Perception of the Scheme Criteria

- The public, those eligible for subsidies, expressed satisfaction in the way that the criteria were easy to understand and reasonably strict.
- The heat pump industry (NOVAP members) wanted stricter criteria regarding both the heat pumps and the installers' qualifications.
- Some felt that the application period was too short (six weeks).
- The control system industry felt that the level of subsidy was too low.
- Other actors offering different kinds of heating systems and other energy saving devices (new windows/better insulation) were not very satisfied.

6.2 Households Perception of the Scheme in General

- The scheme was very well received among those who received support.
 - Easy to understand how to apply.
 - Information provided by Enova was good.
 - The buyers guide provided by Enova was good.
 - Enova provided a high level of service to the applicants.
 - The application procedure was satisfactory.
- Those not making use of the pledge were less satisfied, but still on the positive side (scoring 3.7 on a scale up to 5).

6.3 Effects for the Households after Installation of Heat Pumps

- After a total evaluation, more than 90 % of the households reported better comfort and indoor air climate after the installation.
- To a certain degree, households reported on operational experiences. Some heat pump owners reported on problems related to lack of training as well as technical problems. 11 % experienced technical problems so severe that they needed to call the installer. Though a surprisingly high number, this problem is not reflected in the question on homeowner satisfaction, which is very high.
- 65–70 % of households are satisfied with the service and the availability of the installer, while 8 % are not satisfied.
- A large number of households are satisfied with the technical quality of the equipment (88–96%). 4% are not at all satisfied with their heat pump. Still, 97.3 % reports that the heat pumps are working as well now (a year later) as they were when new.
- Households are satisfied with their investment (more than 90 %), while 4.7 % of heat pump owners are dissatisfied with their heat pump investment.

6.4 Energy Results and Economy for Household Heat Pump Installations

- Average electricity saving (temperature corrected) per household in the heat pump group, is calculated at approximately 5,100 kWh per year. Electricity consumption data was submitted from the homeowners' electricity suppliers, and electricity saving data was calculated based on those data.
- New heating technology shifts the composition of energy mix used in households, and the usage of wood and oil is reported to have decreased. This will in principal reduce the reduction in electricity savings.
- Calculations based on investments, annual maintenance, operational time, and energy prices, has shown that the investment was indeed economic for about 72.8 % of the homeowners investing in heat pump (the investment support taken into account). Further analysis will take place to identify characteristics for households where the investment was not economic.
- More than 50 % of the homeowners reported that they would have undertaken this investment also without the investment support scheme. This indicates that the scheme may not have been the trigger for investments it was intended to be.

6.5 Effects on the Heat Pump Markets

As opposed to the other technologies included in the Household Support Scheme, the heat pump market was relatively mature at the stage of subsidy introduction, and this might also be one of the reasons why the vast majority chose to install heat pumps. The main findings were:

- The heat pump market was in strong growth already before the scheme was introduced.
- About one third of the heat pumps sold in 2003 received support.
- The scheme gave heat pumps a “governmental approval,” thus participating to making heat pump technology more known and accepted also outside the scheme.
- The market volume in 2004 is back at 2002-level.
- Several of the new heat pump companies from 2003 have already exited the market.

7 FUTURE MARKET PROSPECTS AND TRENDS

7.1 Post-Boom Experiences

Experiences show that the heat pump market is quite sensitive to what is discussed in the media. In early November 2003 there was a full stop in heat pump sales, and the plausible reason is negative media attention. First, there was a discussion on the potential *negative health effects* of the air-to-air heat pumps. Arguments were that air is distributed from heat pumps has unfavourably high temperature, and that the heat pumps contributed to increased dust circulation in the room or building. The second issue was that the industry association for the companies selling baseboard heaters launched an aggressive marketing campaign, where potential problems with air-to-air heat pumps were highlighted. Finally, also the heat pump industry cautioned against the do-it-yourself kits. All this resulted in a “market shut-down”.

Then in 2004 the market has been relatively hot again, and indications are that total sales last year will end up somewhere between 20,000 and 25,000 units. This figure is, of course, far from the record year in 2003, but perhaps a more realistic market volume during a normal year. Still the level is high compared to the market before 2003.

7.2 Future Prospects

Prospects should be great for future growth in the Norwegian heat pump market. The residential sector consumes about 30 TWh of energy each year for heating and domestic hot water supply. Of the total figure, 21 TWh are electricity. If domestic hot water supply and direct electric heating is replaced with heat pumps, 14 TWh can be saved only in the residential sector. Norway still has among the lowest electricity prices in Europe. With an electricity market more integrated with Europe, future electricity prices could to continue to rise. There is also still a significant potential to replace oil heating with heat pumps in the residential sector. The alternatives to heat pumps are district heating, bioenergy and natural gas. With the Norwegian topography it is in many cases expensive to build district heating. The challenge with both bioenergy and natural gas is distribution, but in some regions this will be an alternative to heat pumps. Large energy companies have put alternative and renewable energy on the agenda, and the market is rapidly increasing.

For many years there will be a substantial market for single unit air-to-air heat pumps. For single-family houses without hydronic distribution systems, this will be the best way for energy saving with a modest investment. Also expected is a growth in the market for other and more advanced systems with a higher initial cost, but where equipment efficiency is higher and energy saving potentials greater.

Some of the products where market growth is expected due to technical development are:

- Air-to-water heat pumps with inverter control.
- Air-to-water heat pumps with CO₂ and R-410A as working fluid that combines heating and domestic hot water supply.
- Ground source heat pumps with new technology and other working fluids.
- Specially designed systems for new low and ultra-low energy houses.

A heating system with heat pumps requires a good product and proper installation. Training and education of designers and installers is paramount.

Other factors that would influence the future growth rate in the heat pump market are:

- Implementation of the new European Union directive on energy labeling and energy performance of buildings.
- Actions for meeting Norway’s obligations to the Kyoto Protocol.

- Energy utilities' involvement in market activities.
- Future developments in energy prices and energy taxes.
- Interest rates and financing schemes for heat pumps.
- Media attention.

Owing to the fact that there are so many factors that influence the heat pump market, it is difficult to have any clear expectation regarding volume during the next years.

8 CONCLUSIONS

- During 2003, Norway experienced an unprecedented increase in sales of heat pumps, and more than 55,000 units were sold. The normal figures during most of the 1990s were between 1,000 and 2,000.
- The main factors behind the tremendous increase in sales are believed to be: the extremely high energy prices, a systematic effort over time to build a solid reputation for heat pumps, increased media attention, increased competition in the market with resulting low equipment prices, improved product quality, and the investment subsidy scheme.
- The investment subsidy scheme was a success in the sense that it contributed significantly in raising the awareness of heat pumps, and it has also received a very favorable evaluation with regard to customer satisfaction, energy savings, and so far limited operational problems. The fact that more than 50 % of household would have installed heat pumps regardless of the scheme suggests that the support scheme might not have reached the intended target group. The scheme was also launched while the market for heat pumps was already in growth, thus contributing to destabilize the market.
- Prospects for heat pumps in Norway are still bright. There is a large untapped market, and the public has now really discovered heat pumps. The high electricity prices experienced during the first quarter of 2003 has been a real eye-opener, and homeowners are now more than ever preoccupied with not being totally dependent on electricity as the only source for heating.
- All market booms are associated with potential problems. Problems were also experienced in Norway. The hopes is that the number of problem installations after 2003 is limited, and that the market will not suffer from the "bad reputation effect."

REFERENCES

SSB and NVE, Publicly available statistics from the Statistics Norway (www.ssb.no) and the Norwegian Water Resources and Energy Directorate (www.nve.no)

NorPool, Publicly available statistics from Nordpool (www.nordpool.com)

NOVAP: Sales statistics from the Norwegian Heat Pump Association, 2004

Bjørnstad, E., Grande, J., Sand R., and Wendelborg, C.: *Evaluering av tilskuddsordningen til varmepumper, pelletskaminer og styringssystemer*. DRAFT. Nord-Trøndelagsforskning, Steinkjer, Norway, 2005