Flexibility with

(hybrid) heat pumps

With contributions from:

IEA Annex 42 ‘Heat pumps in smart grids’

IEA Annex 45 ‘Hybrid heat pumps’

Tesla Gygafactory

50 GwH output in battery systems in 2020

Source: Tesla Motors

BUSINESS DEVELOPMENT HOLLAND B.V.

Process- and strategy consultants

B D H

COMPANY PROFILE

Peter Wagener BDH – NL

SCOPE OF ACTIVITIES

What are we doing?

- Scenario development:
  - Energy consumption;
  - Grid load simulations.
- Project management:
  - Renewable energy programs.
- Studies:
  - Potential studies;
  - Positioning papers;
  - Technology books.
- Tooling:
  - Online configurators;
  - Scenario tools;

EUROPEAN HEAT PUMP SUMMIT

PARTICIPANTS ANNEX 42 & ANNEX 45

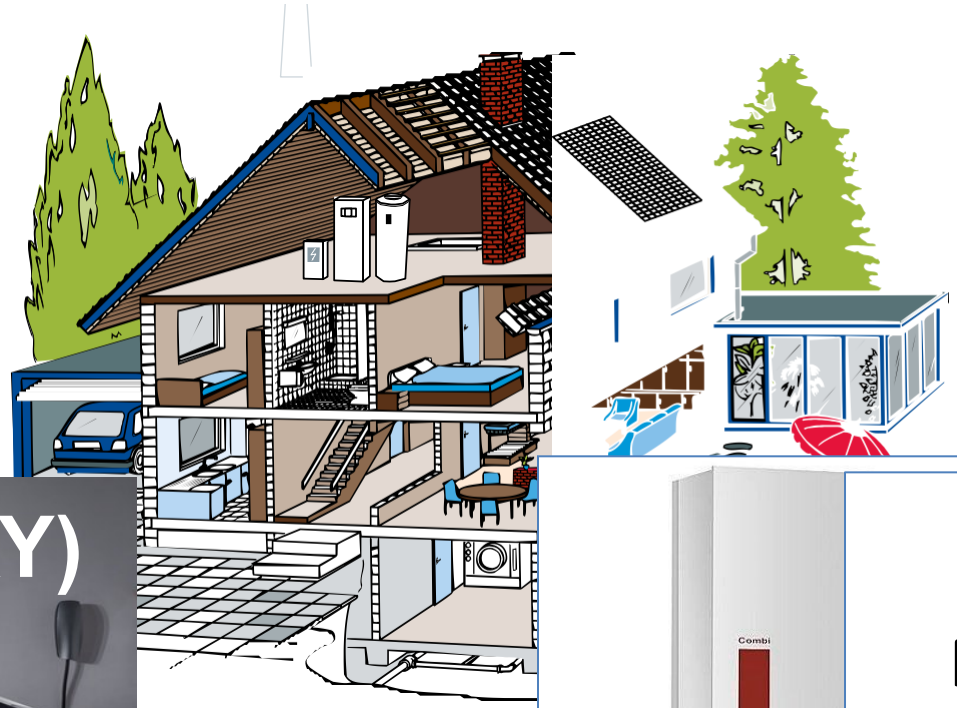
Annex #	42	45
1. France	X	X
2. Denmark	X	-
3. The Netherlands	X	X
4. Germany	X	X
5. Austria	X	-
6. Switzerland	X	-
7. Southern-Korea	X	Pending
8. United States of America	X	-
9. United Kingdom	X	X
10. Italy	-	Pending

rnational
gy Agency

EUROPEAN HEAT PUMP SUMMIT

Annex 42

SMART GRID COMPONENTS



HEAT PUMP + THERMAL STORAGE

EUROPEAN HEAT PUMP SUMMIT

Annex 42

ELECTRIC MOBILITY AND HEAT PUMPS

ARE ALREADY REASON ENOUGH

FOR SMART GRIDS (BLACK STARTS!)

WIND AND SOLAR POWER IN ADDITION

WILL STRETCH THE CHALLENGE

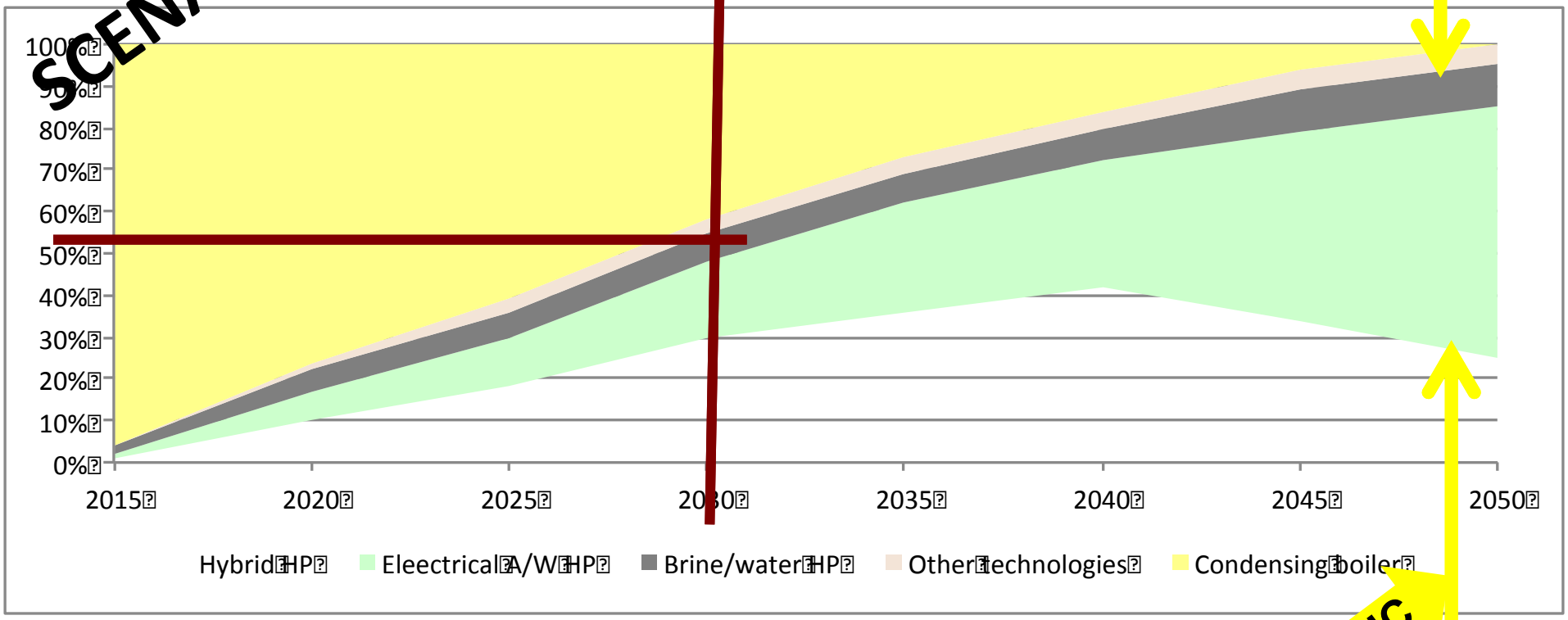
International Energy Agency

HEATING market netherlands '15 –'50 in %

Annex 42

SCENARIO!

2030



ALL ELECTRIC

DUTCH HOUSING STOCK

7.000.000 houses (Approx. 500.000 on thermal grids)

GRID LOAD PROFILES

LOAD PROFILE WINTERDAY 2015

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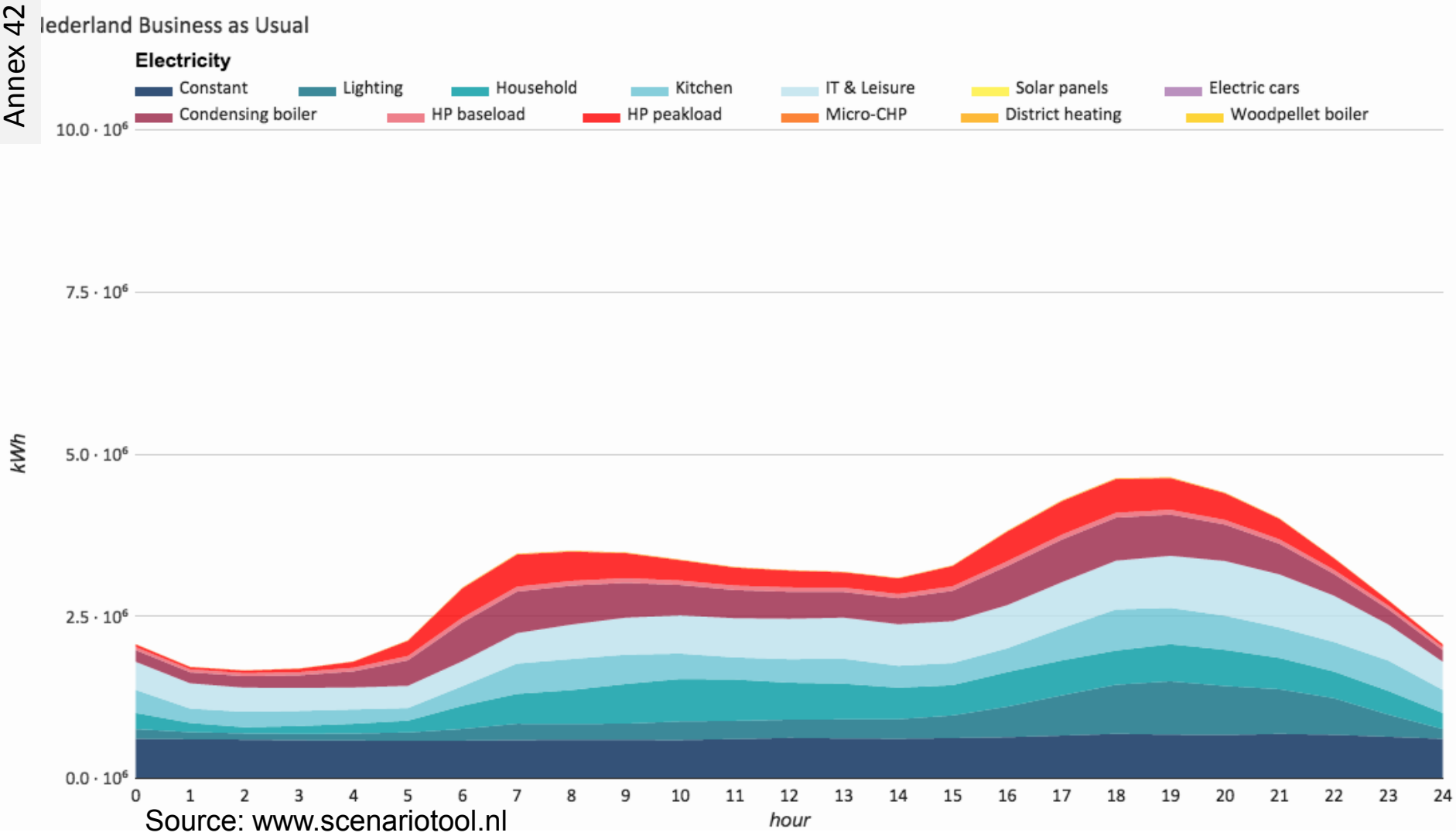
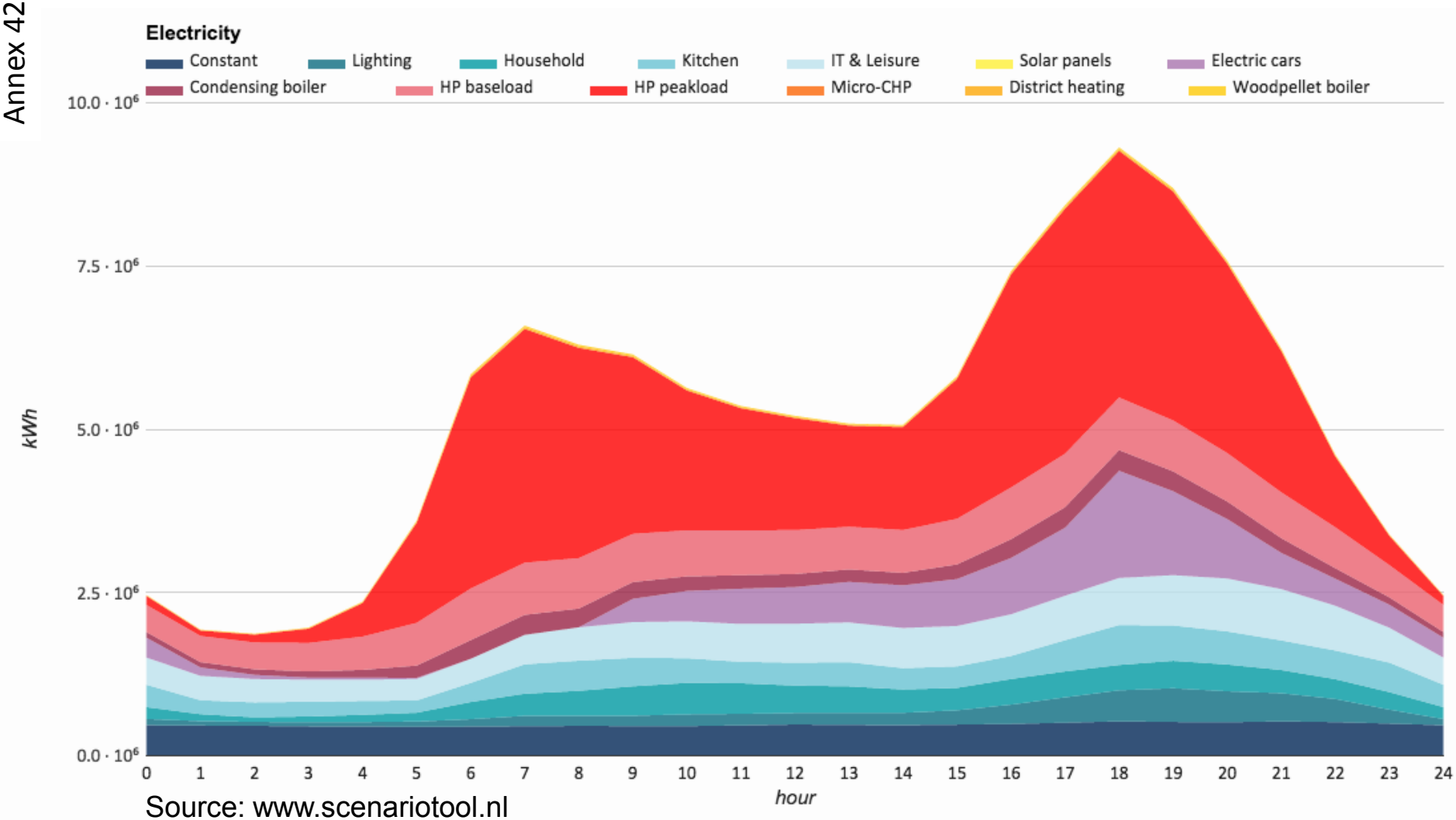


Source: www.scenariotool.nl

WINTERDAY 2030

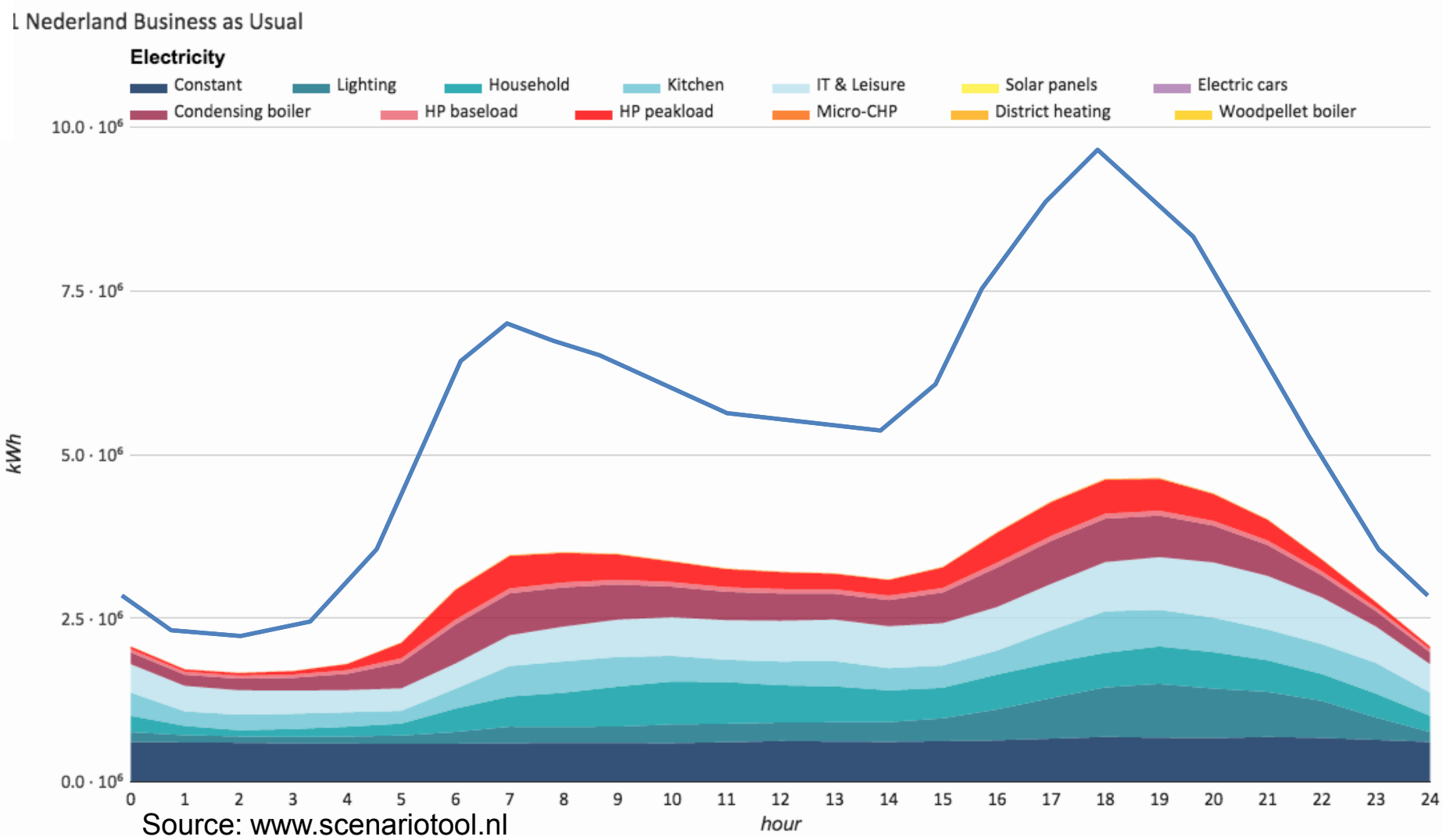
Annex 42



Source: www.scenariotool.nl

WINTERDAY 2013 **VS** WINTERDAY 2030

Annex 42



Source: www.scenariotool.nl

GRID LOAD **SUMMERDAY** 2015

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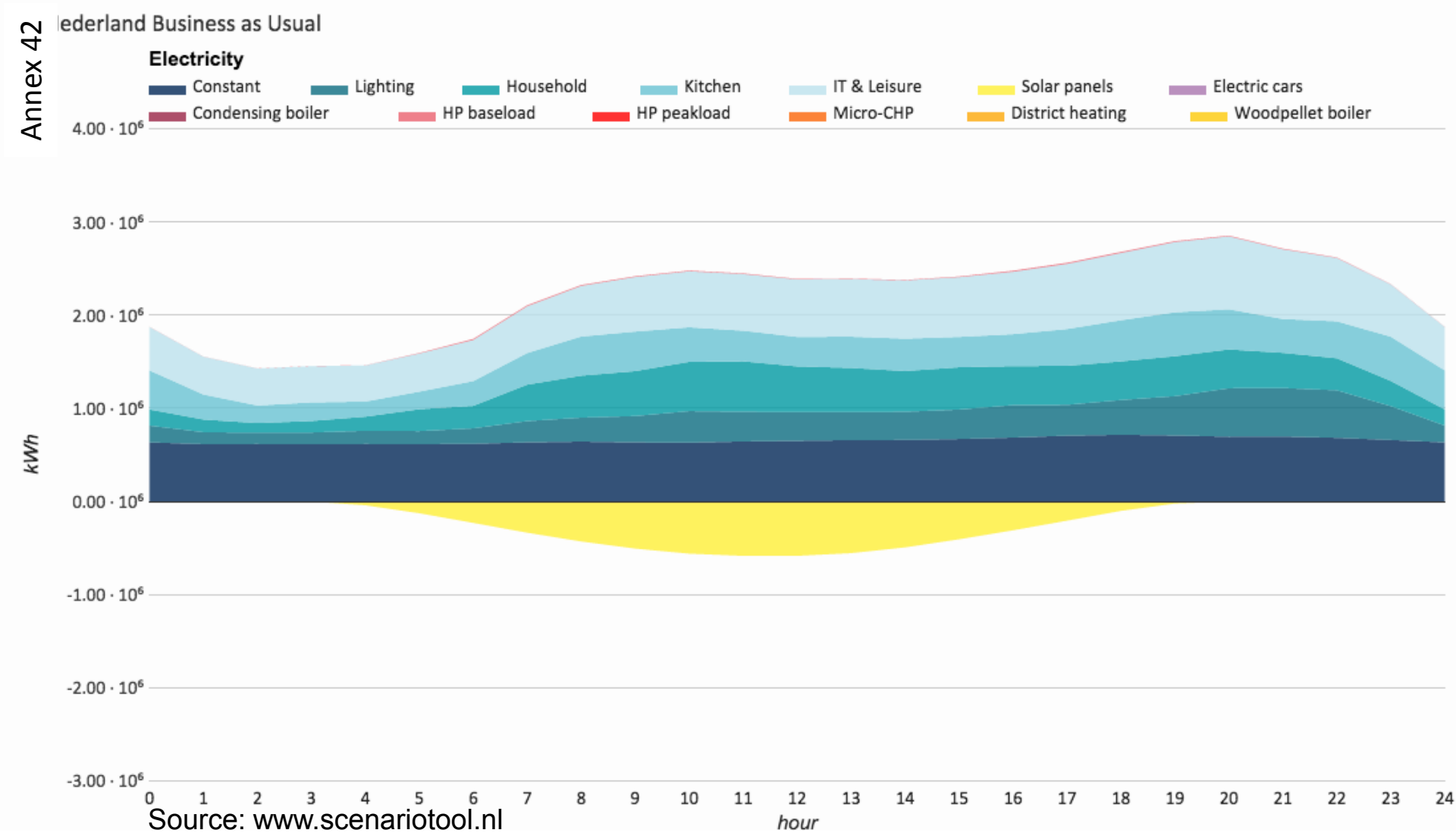
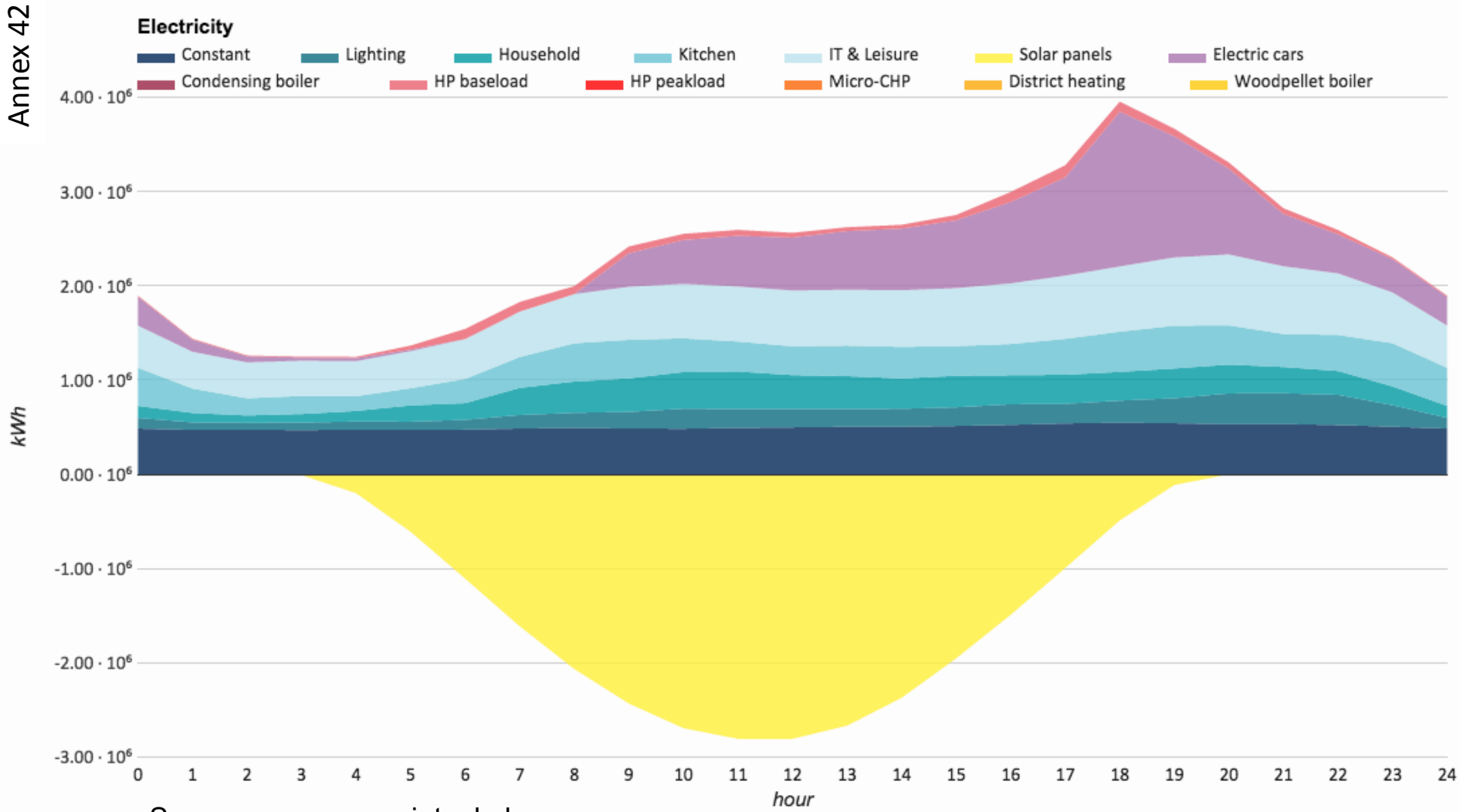


Source: www.scenariotool.nl

GRID LOAD **SUMMERDAY** 2030

Annex 42

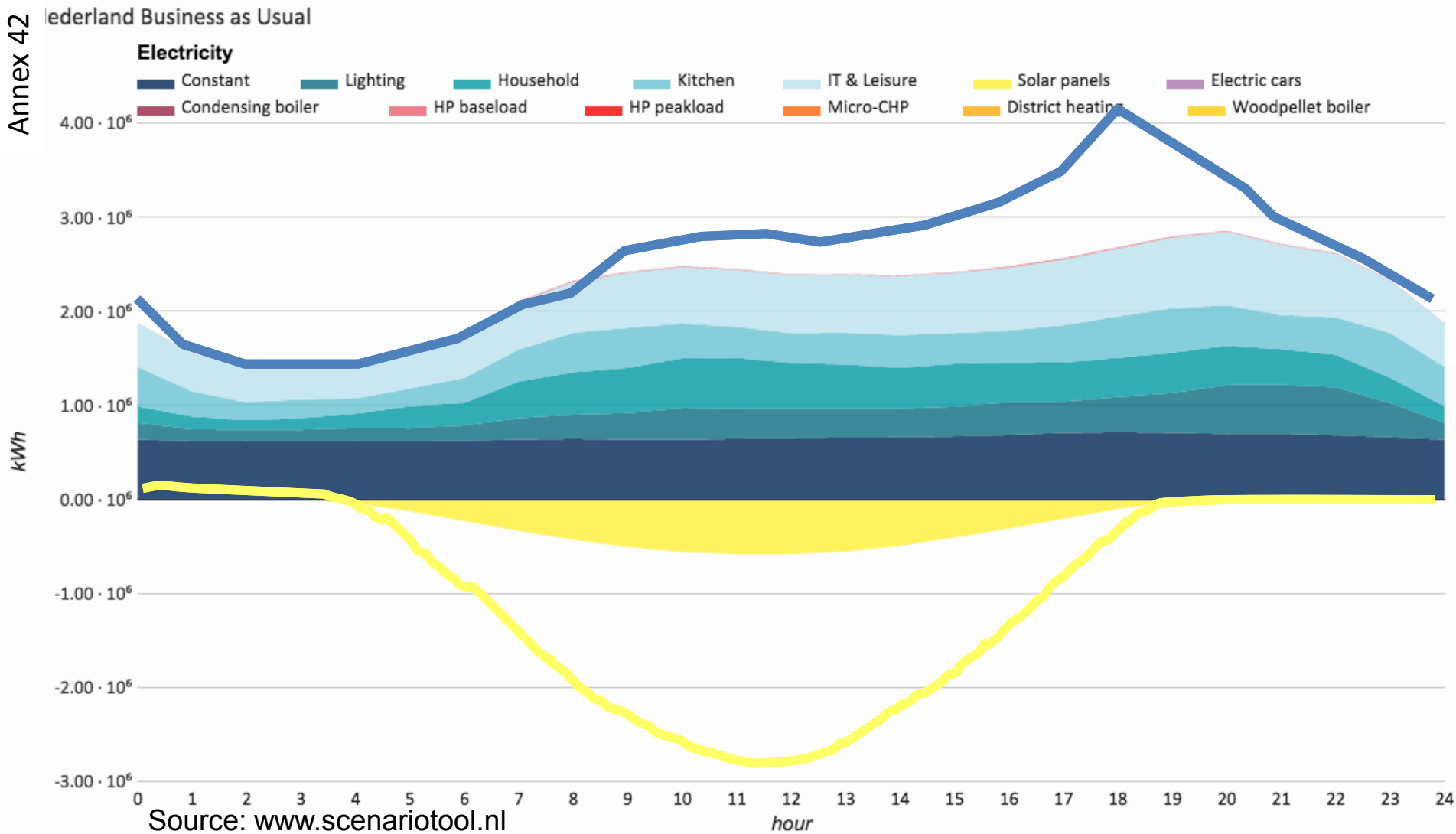


Source: www.scenariotool.nl

Source: www.scenariotool.nl

GRID LOAD **SUMMERDAY** 2015 **VS** 2030

Annex 42



Source: www.scenariotool.nl

2015 VERSUS 2030, SUMMER AND WINTERDAY

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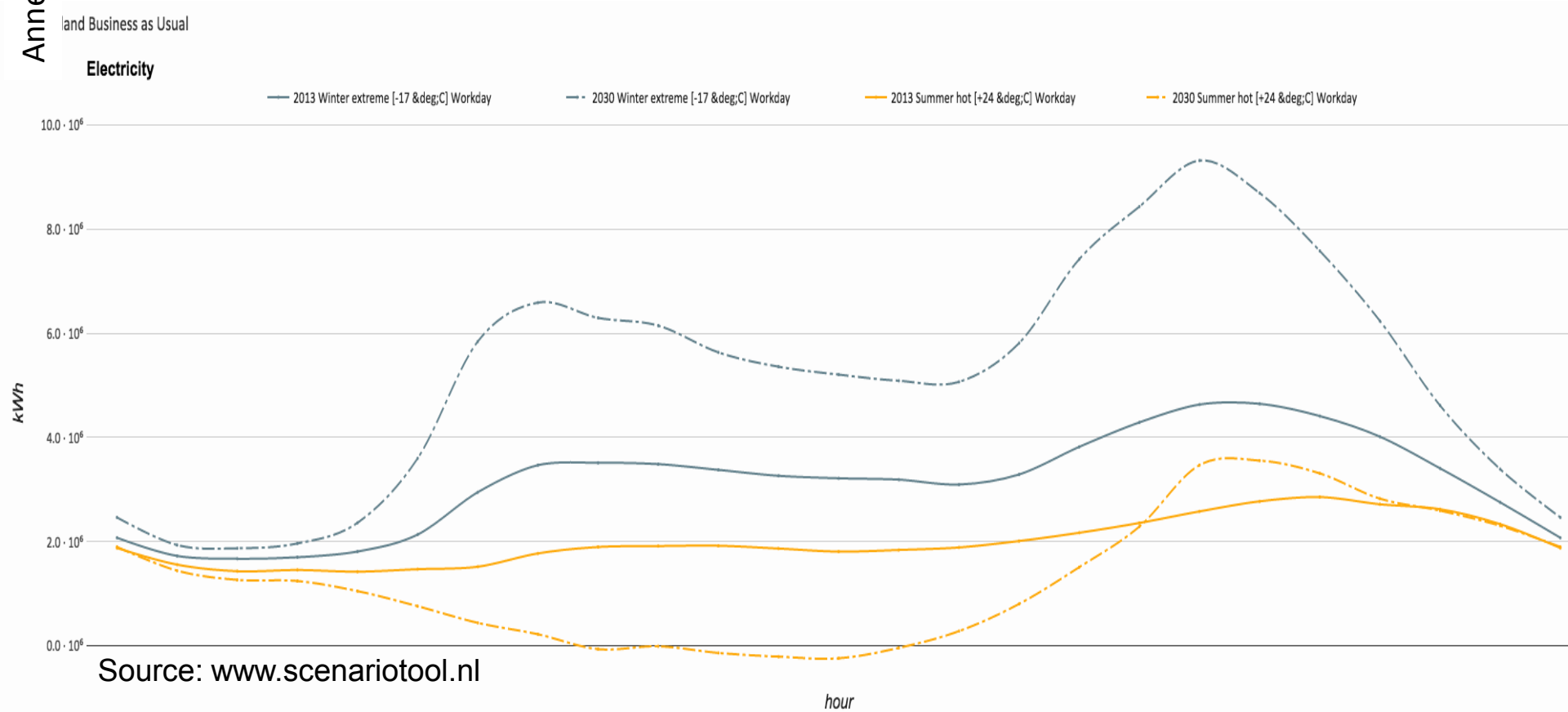


Source: www.scenariotool.nl

DRIVERS FOR HEAT PUMPS IN SMART GRIDS

- Available versus needed grid capacity;
- Simultaneity of electricity consumption;
- Increasing production renewable power;
- Growing use of heat pump technology;
- System changes:
  Electricity consumption follows availability
  instead of central production follows demand;

DRIVERS FOR HEAT PUMPS IN SMART GRIDS (2)

- Need for flexibility by means of :
  - Peak load shaving;
  - Demand response management;
  - Storage options; Thermal and electrical storage
- Connection from 1st to 2nd circle;
  - Electrical power > thermal energy;

CREATING FLEXIBILITY WITH HEAT PUMPS
ENERGY STORAGE - THERMAL

Latent storage options:

- Phase changing materials
  (Lifetime expectancy / mind energy losses)
- Building structure
  (Design requirements, less retro fit opportunity)
- Thermal grids;
- Buffer tanks (Cheap, mind energy losses)

Chemical storage:

(High temperature, no loss)

CRITERIA FOR BUFFERING THERMAL ENERGY

- Speed for load and unloading of heat;
- Total capacity;
- Manufacturing costs;
- Installation costs;
- Charging and discharging thermal energy losses.

IEA ANNEX 42
CASE SCENARIO APPROACH PER COUNTRY;

EXAMPLE:
UNITED KINGDOM

Peter Wagener BDH – NL

UK: CURRENT BARRIERS RELEVANT TO MASS HEAT PUMP DEPLOYMENT

- Most houses have:
  - Limited storage capacity;
  - Limited space for buffer tanks required for heat pumps;
- Many houses have old heat emitters;
  With high temperature distribution. Use of heat pumps would require emitters replacement;
- The majority of heating systems is used bimodal;
  Or in bursts this ≠ heat pump operation >>demand spikes & poor heat pump efficiency;
- High average age of UK housing stock;
  Means low thermal efficiency;

UK: KEY DRIVERS FOR HP FLEXIBILITY IN THE UK

Now

- **Grid capacity requirements** from a upcoming mass deployment of heat pumps. Estimated to be 60% increase in cold winter evening peak (approx. 25GW)
- **Local grid congestion**, DNOs nervous of potential requirements for large scale grid reinforcement works >> need for more knowledge
- Key requirement: **Shift demand** from the evening peak >> smart grids option

Future challenge:

- Renewables balancing, in particular large scale wind

UK COMMON HOUSE TYPES

Semi detached – 1945-1964

UK COMMON HOUSE TYPES

Semi detached 1919-1944

UK COMMON HOUSE TYPES

Mid-Terrace Pre 1919

UK COMMON HOUSE TYPES

Detached

UK COMMON HOUSE TYPES

Purpose built low rise flats

EUROPEAN HEAT PUMP SUMMIT

IEA Annex 42 Task #1 Reports; Markets

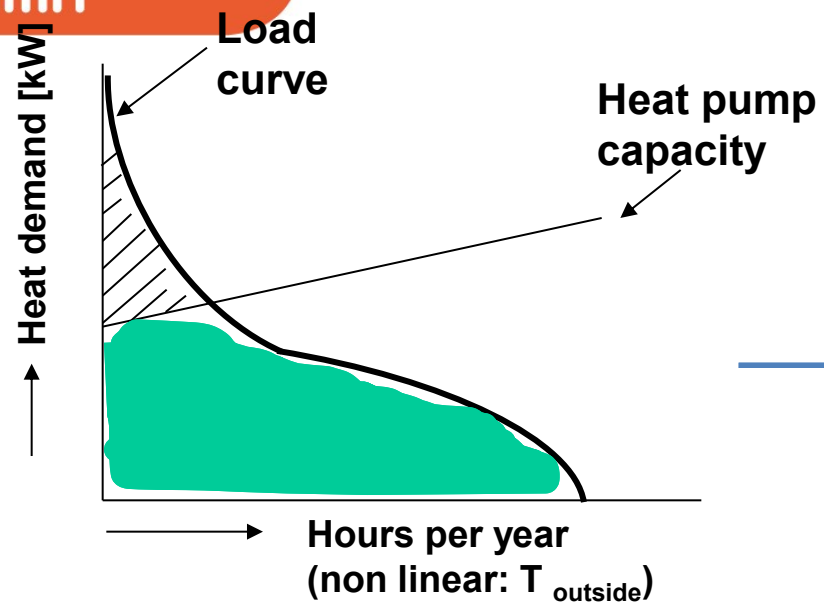
Differentiator	UK	DE	FR	NL	KR	US	CH	DK
1. Drivers for HP in smart grid / flexibility	🟡		🟢	🟡	🟢	🟢	🟡	
2. Potential size of flexible HP resource			🟢			🟡	🟢	
3. Building characteristics – impact on flexibility	🔴	🟡	🟡	🔴	🟡		🟡	🟡
4. Energy prices / structures / tariffs – impact on flexibility	🟡				🔴	🟡	🟡	
5. End-users – impact on flexibility	🔴		🟡		🔴	🟡	🟡	🟡
Overall score		🟡			🟡	🟡		🟡

Characteristics of markets for enabling capturing of flexibility from heat pumps

HYBRID HEAT PUMP IS..

- **Ambient air;**
- **Exhaust air;**
- **Ambient/exhaust air;**

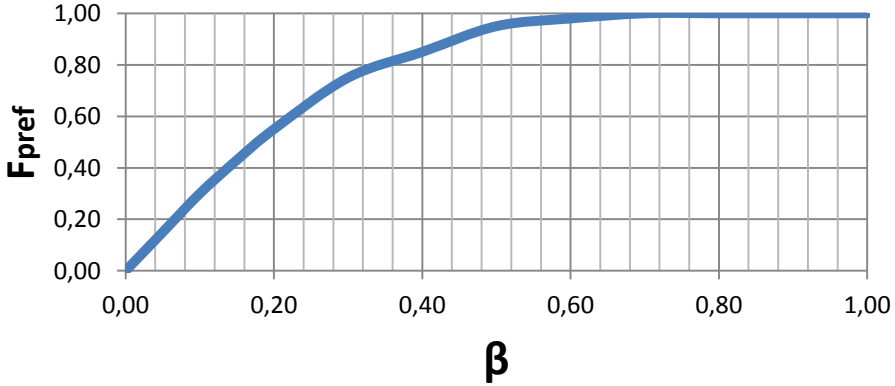
"PRE-HYBRID" SITUATION



NEN 7120 Table 14.9

β	F_{pref}
0,00	0,00
0,05	0,15
0,10	0,30
0,15	0,43
0,20	0,55
0,30	0,75
0,40	0,85
0,50	0,95
0,60	0,98
0,70	1,00
0,80	1,00
0,90	1,00
1,00	1,00

Contribution by heat pump Fpref as function of β



FLEXIBILITY WITH HYBRID HEAT PUMPS

- *All items as adressed before are, plus:*
- Flexibility by managing het bivalency point;

  switch based on primary energy performance;
- Flexibility in energy carrier; switch between elektricity and gas based on grid load;
- Flexibility based on 'wholesale pricing'

  elektricity for end users
  – (Dutch TKI research project 2015/2016)

(HYBRID) HP'S IN SMART GRIDS FLEXIBILITY DEPENDS ON..

1. Characteristics of the building stock;
2. Availability, affordability home battery facilities;
3. 'Tangible' advantages for the end user;
4. 'Wholesale' electricity pricing for end-users;
5. Standardisation of communication protocols;
6. Transparant and cost efficient arrangements;
7. "Foolproof" and user friendly (IT) technology;
8. DO NOT wait for the ultimate solution, it might never come

HP'S IN SMART GRIDS, WHO BENEFITS FROM IT?

First of all: Smart grids = industry pushed development

Society wide benefits:

- Integrated approach for electrification of mobility and h
- Capability of handling intermittent produced renewable
- Less fossile fueled power production;
- Less geopolitical dependancy on fossile fuel;

End user benefits:

- Reliable, available and affordable 'green' power.

HP'S IN SMART GRIDS, WHO BENEFITS FROM IT? (2)

District Service Operator's (DSO):

- Security;
- Robust reliability in power grids;
- Reduced network costs (Avoided future investments);

Government:

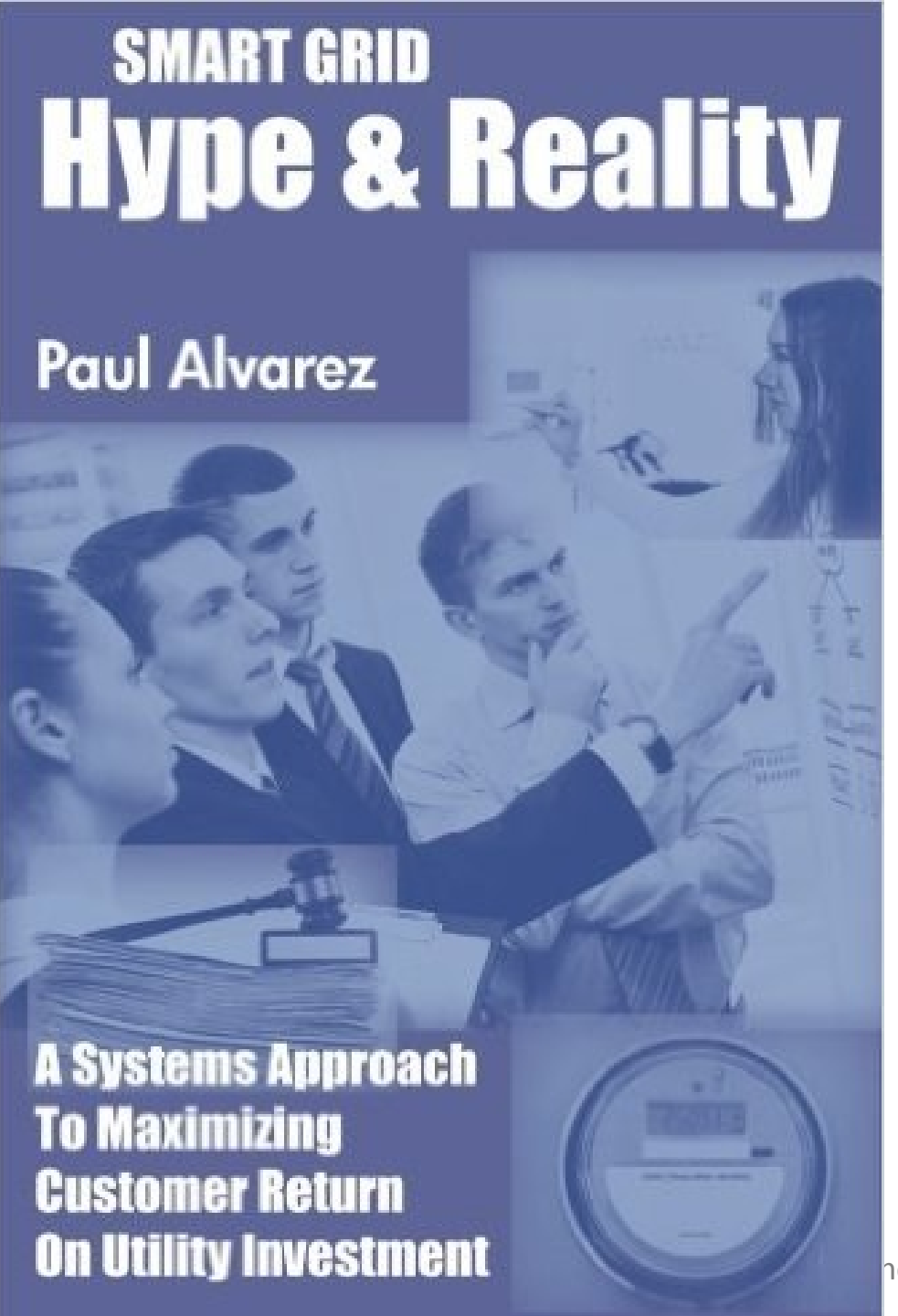
- Increased geo political independency;
- 'Green policy' execution, meeting EU targets.
- Less necessity of own fossil energy sources (NL, UK, Ger)

DHPA
DUTCH HEAT PUMP ASSOCIATION

POSITIONING PAPER:

‘HEAT PUMPS IN DOMESTIC HOUSING AND DEMAND MANAGEMENT’

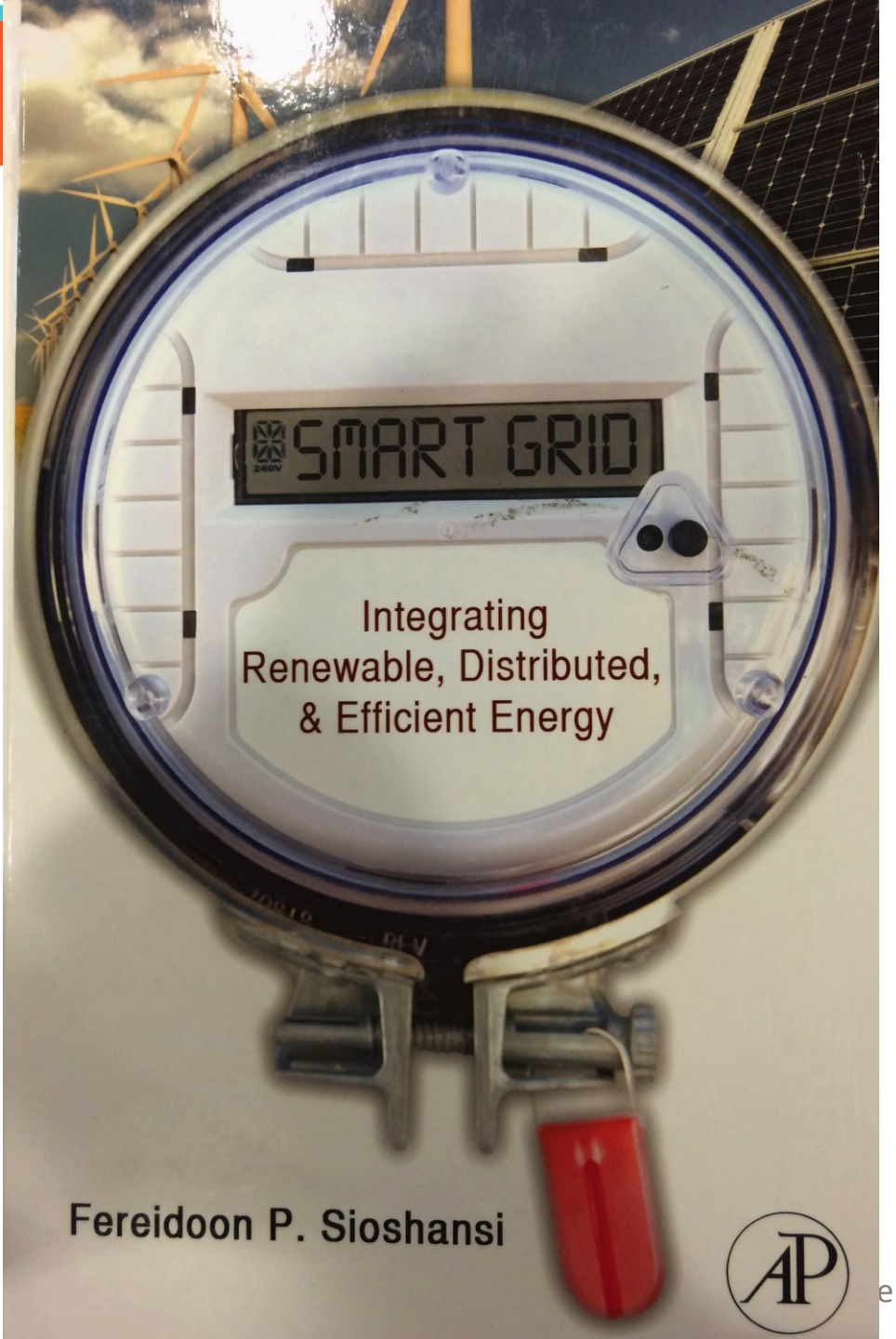
International Energy Agency



BOOK:
'SMART GRID, HYPE AND REALITY'

A SYSTEMS APPROACH TO MAXIMIZING CUSTOMER RETURN ON UTILITY INVESTMENT

International Energy Agency



BOOK:
'SMART GRID'

INTERGRATING, RENEWABLE DISTRIBUTED & EFFICIENT ENERGY

International Energy Agency

MORE INFORMATION:

- www.annex42.nl
- www.annex45.nl
- www.iea.org
- www.heatpumpcentre.org
- www.bdho.nl
- www.scenariotool.nl

Thank you

for your attention

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