CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

ECN

(Micro) Combined Heat & Power Technology Transfer to Iran

Report for Activity 1 and 2

Authors
Marc Londo
Robert de Smidt
Hamid Mozaffarian

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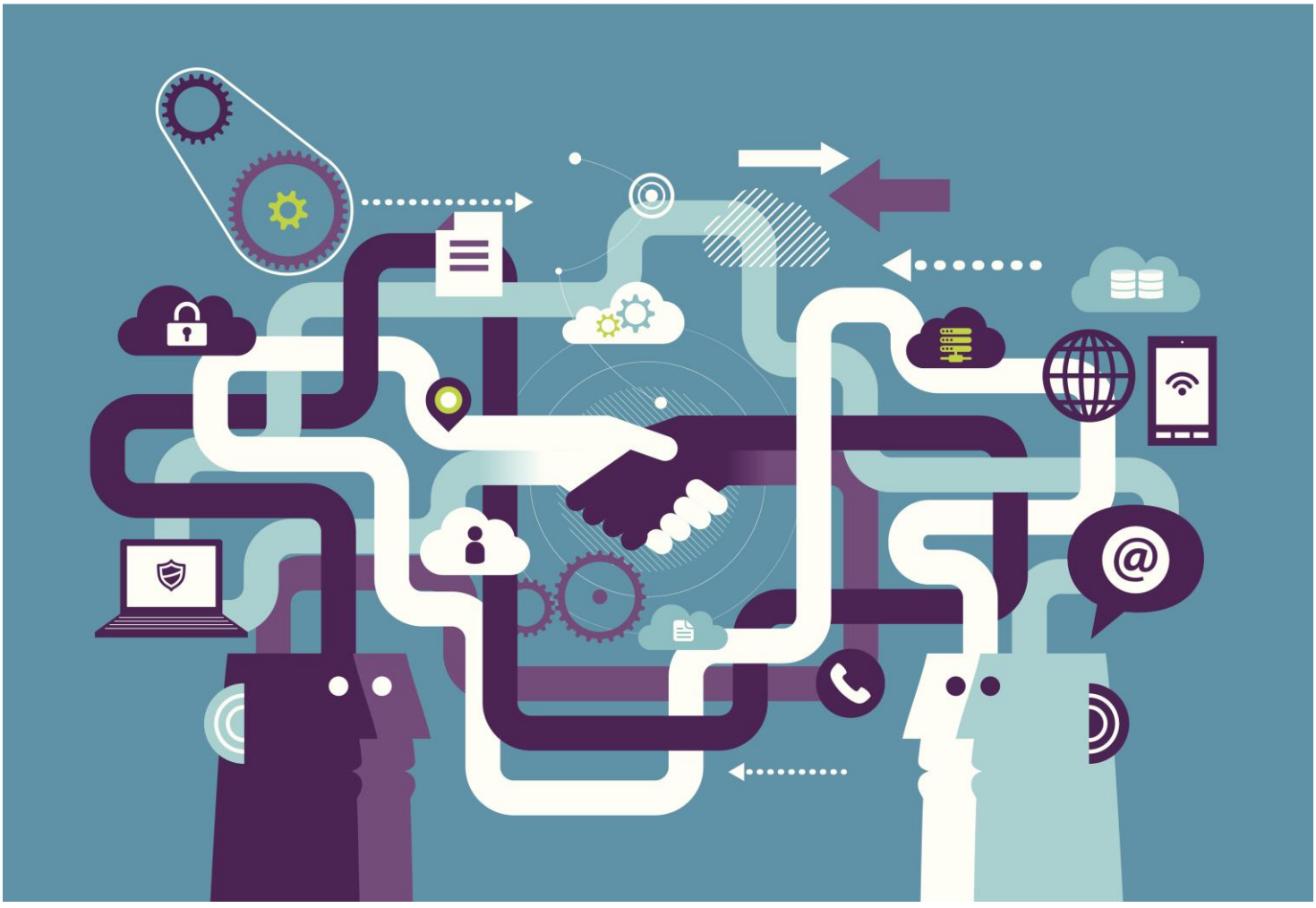

Acknowledgement

This report has been produced in the context of a CTCN Technical Assistance/ Response Plan. The related Request Identification Number is 2014-018/IRN-02.

Within ECN, the project has been carried out under project number 5.3785.02.01.

List of abbreviations

CHP	Combined heat & power
CITC	Centre of Innovation Technology Cooperation
CTCN	Climate Technology Centre & Network
ECN	Energy research Centre of the Netherlands
MCHP	Micro combined heat & power
NDE	National Designated Entity
TGEC	Tamkar Gas Equipment Company
UNIDO	United Nations Industrial Development Organisation

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Introduction

Energy use intensity is very high in Iran. Since the household and commercial consumers are one of the main sectors of energy demand in the country, and considering the lossy process of electricity production in conventional power generation methods, all the energy-related ministries in Iran are interested in decentralized, high-efficiency technologies for supplying energy (both electricity and thermal energy) to the household and commercial sectors.

It is expected that a CHP & MCHP system would result in a considerable annual natural gas saving, compared to conventional separated generation of heat and power for the household and commercial sectors. There are about 550,000 buildings that use central heating in Iran. If 20% of these buildings would be covered by CHP & MCHP, this would lead to a considerable greenhouse gas emission reduction. Moreover, the localisation of the CHP & MCHP production offers Iran a potential market share for this technology in the region.

In the past, several studies have been carried out in Iran to identify the best technology for (M)CHP, market needs, and implementation potential. Also, some efforts are ongoing concerning technology transfer through purchasing and installation of equipment, as well as localisation of production of equipment and after sales service support.

This CTCN assistance project has built up upon the available knowledge and aims to facilitate the transfer of CHP & MCHP technology from foreign suppliers to Iran. It is part of a broader programme with the aim to produce the prototype of the transferred CHP & MCHP technology including the related after-sales services in Iran.

Key partners in the project are:

- Tamkar Gas Equipment Company (TGEC, or Tamkar), an Iranian company providing management, engineering, procurement, construction and financing services for industrial projects mainly focused on oil, gas and petrochemical projects, the Iranian counterpart for the foreseen technology transfer.
- Centre of Innovation Technology Cooperation (CITC), an Iranian government research centre, acting as facilitator and coordinator of the planned activities.
- Energy research Centre of the Netherlands (ECN), an energy technology and policy research institute and knowledge partner of CTCN, providing the technical support to the project.

The Response Plan comprises four activities (see Appendix A). CTCN assistance is provided for the first two activities of this broader programme. These activities are:
Activity 1 – Identification of the companies with CHP & MCHP technical knowledge;
Activity 2 – Business communication with selected CHP companies.

This report summarises the outcomes of activities 1 and 2, which were supported by CTCN.

1. Activity 1: Identification of the companies with CHP & MCHP technical knowledge

The first activity was carried out in the following steps:

- Activity 1.1 – List of requirements CHP & MCHP for Iran;
- Activity 1.2 – Survey CHP & MCHP companies (long list);
- Activity 1.3 – Matching long list with list of requirements (short list);
- Activity 1.4 – Communication long list/short list with Iran;
- Activity 1.5 – Selection CHP & MCHP companies with technical knowledge, based upon TGEC's option and discretion.

In the course of the activity, ECN, TGEC and CITC had a series of five telephone conferences (telcos) in which preliminary results were discussed and next steps decided upon.

Activity 1.1: List of requirements

- A list of technical requirements was agreed upon in the first telco, March 2016.
- A list of required non-technical information was provided by TGEC after the second telco, May 2016.
- After the third telco, TGEC provided another detailed list of information, to be provided for the shortlisted companies.

The full set of requirements and required information is included in this report as Appendix B.

Activity 1.2: Survey of suppliers, longlist.

- In preparation of the second telco, ECN provided a first longlist of potential suppliers.
- In the second telco, ECN was requested to expand the longlist in order to find more companies that meet the Iran requirements.
- ECN performed an additional review of suppliers and expanded the longlist.
- The expanded longlist was shared and discussed with the Iranian parties in the third telco, October 26, 2016. In this telco, TGEC requested an additional list of potential suppliers for CHP systems based on a Stirling engine.
- ECN provided the requested additional list in the documentation for the fourth telco, scheduled November 11, 2016, which was replaced by an e-mail exchange of information and views.

The full set of longlisted suppliers is part of the slide pack for telco no. 5, included as Appendix C

Activity 1.3: Selection of suppliers against criteria, shortlist

- On the basis of the longlist and the criteria set up in activity 1.1, ECN proposed a shortlist of suppliers for the three technologies (Stirling, gas engine, turbine). This documentation also contained all publicly traceable information on the shortlisted companies, as required by TGEC after the third telco (see Activity 1.1).
- These lists were proposed in the fifth telco, February 13, 2017.

The shortlists of the different types of CHP are also included in Appendix C. For these shortlisted companies, Appendix D contains the more detailed information.

Activity 1.4: Communication with Iran

- As mentioned, ECN, TGEC and CITC had various communications with Iran.

Activity 1.5: Selection of companies to be contacted:

- In the fifth telco, February 13, 2017, ECN and TGEC jointly came to a proposal for selecting 5 shortlisted companies to be contacted personally. Shortly after this telco, ECN received go-ahead to start contacting these companies.

These suppliers, their types of CHP and the identified models are summarised in Table 1.

Table 1: Shortlisted suppliers for the various kinds of CHP, the end result of Activity 1.

	Technology, model		
Supplier	**Stirling CHP**	**Combustion engine CHP**	**Turbine CHP**
Remeha	eVita 28c	ELW 20	
Viessmann	Vitotwin 300-W	Vitobloc EM-20	
Yanmar		CP25WE	
Tedom		Micro T30	
MTT			Enertwin

2. Activity 2: Business communication with selected CHP companies

The second activity consisted of the following sub-activities:

- Activity 2.1 – Contact selected CHP & MCHP companies to map their willingness for potential cooperation with Iran;
- Activity 2.2 – Communication of the list of interested CHP & MCHP companies with Iran;
- Activity 2.3 – Selection CHP & MCHP technology owners for business communication;
- Activity 2.4 – Organizing business communications.

Activity 2.1 – Contact selected CHP & MCHP companies to map their willingness for potential cooperation with Iran;

- ECN contacted each of the five shortlisted suppliers and explored their interest in entering into a technology transfer activity.
- In this exploration, ECN also requested any missing information requested by TGEC to be provided by the supplier.

Activity 2.2 – Communication of the list of interested CHP & MCHP companies with Iran;

- ECN consolidated the key findings from the personal contacts with the selected suppliers in a next slide pack. These findings included supplier's interest in exploring opportunities for technology transfer.
- On the basis of these contacts, ECN also updated the detailed list of business information, to the extent the suppliers were willing to provide these before any business communication.
- These findings were discussed with TGEC in the sixth telco, April 5, 2017.
- The slide pack for this sixth telco can be found in Appendix E.

Activity 2.3: Selection technology owners for business communication

- In the sixth telco, based on the interest of the contacted suppliers, two suppliers were proposed for setting up business communication: Remeha and Viessmann.
- After internal checks with TGEC, we got go-ahead for organising these communications beginning of June.

Activity 2.4 – Organizing business communications

- The first telco with Remeha was held on July 3, the first telco with Viessmann on July 19. For both telcos, ECN provided an agenda, introduced the overall project to the participants, facilitated information exchange, moderated the telco and provided a list of key outcomes afterwards.
- On the basis of these telcos, TGEC and Remeha have entered into further business communication, exchanging data in order to explore the business case for micro-CHP in Iran. The same has started between TGEC and Viessmann, specifically on mini-CHP.
- By mid-august, this process appears to be ongoing, and essentially means that the project has now entered into activity 3 (Technology transfer through purchasing and installation of equipment), or more specifically activity 3.1 (Negotiation with technology owners).

3. Planning for activities 3 and 4

With activities 1 and 2 now finalised, TGEC is now responsible for continuing the established business communication with the two identified suppliers, and further establish technology transfer. As for the planning of the project, we would like to make the following comment.

- In the original proposal, the full project was foreseen to be carried out in two years, and activities 1 and 2 should take approximately 9 months.
- As was communicated earlier, activities 1 and 2 have faced some delay: they have now been finalised 16 months after the start of the project.
- In order to accommodate sufficient time for activities 3 and 4, we propose to extend the duration of the project to 30 months.

APPENDIX A. Project activities

The table below shows the outputs partly provided by the CTCN, the activities that were and will be carried out as part of each output, and the deliverables, explaining the formats in which the results were and will be conveyed.

Table 2: Project activities

Output	Activity	Deliverables	Responsibility
1. Identification of the companies with CHP & MCHP technical knowledge	1.1. List of requirements MCHP for Iran	Report on identification of CHP & MCHP companies with technical knowledge	CTCN
	1.2. Survey CHP & MCHP companies (long list)		
	1.3. Matching long list with list of requirements (shortlist)		
	1.4. Communication long list/short list with Iran		
	1.5. Selection CHP & MCHP companies with technical knowledge, based upon TGEC's option and discretion		
2. Business Communication with the selected interested CHP & MCHP companies	2.1. Contact selected CHP & MCHP companies to map their willingness for potential cooperation with Iran	Organizing business communication with selected interested CHP & MCHP companies	CTCN
	2.2. Communication of the list of interested CHP & MCHP companies with Iran		
	2.3. Selection CHP & MCHP technology owners for business communication		
	2.4. Organizing business communications		
3. Technology transfer through purchasing and installation of equipment	3.1. Negotiation with technology owners	Signed contract with selected CHP & MCHP technology owner to realize technology transfer	TGEC / CITC
	3.2. Receive and review proposals		
	3.3. Sign contract		
4. Localisation of production of equipment and after sales service support	4.1. Technology adaptation to local conditions (market demand, skilled manpower, facilities, infrastructure, etc.)	Skilled manpower, public education, the prototype, after sales service support	CHP & MCHP owner / TGEC / CITC
	4.2. Production (design, construction, installation of equipment, etc.)		
	4.3. Technology uptake (encompassing technology is introduced into the society, study skills as public education)		
	4.4. Technology development (integrating technology into domestic skills and experience to achieve a new technology) → the prototype		

APPENDIX B. List of requirements CHP & MCHP for Iran

The first inventory of the required specifications for CHP & MCHP is presented in Table 3. This list, as part of the activities of the first project output.

Table 3: Preliminary inventory of the required specifications for MCHP

Parameter	Required specification	Comment
Type MCHP	Reciprocating gas engine	
Unit size MCHP	15-20 kWe	Based on base load of heat demands, suitable for multi-family buildings or small offices with net internal area of 250 – 300 m^2
Heat-to-power ratio	1.7 – 2.0	
Fuel type	Natural gas	
Price range	800 – 1000 $/kWe	$12,000 – 20,000
Current competing options	- Boiler rooms to supply heat through conventional steam boiler or condensing boiler - Power plants to supply electricity	
Existing infrastructure	- Gas grid - Electricity grid	Both existing
Allowable emissions		Although the Department of Environment in Iran is preparing environmental standards, there is no standard for using MCHP in Iran yet.
Allowable noise level	55 dB	
Climatic zones in Iran		- Caspian zone (Caucasian and mid-European affinities, slightly Mediterranean on the coast) - Beluchi zone (Saharo-Sindian and subtropical affinities) - Irano-Turanian zone (slight Mediterranean affinities) a. Subdesertic zone b. Steppic zone c. Substeppic zone d. Xerophilous forest zone e. High-mountain zone

Also, TGEC provided some information of currently operational CHP units in Iran (Personal communication of Mrs. Aliakbari, May 4, 2016). Currently 8 power plants are based on gas engines (CHP):

- 4 plants of 1 MW_e
- 2 plants of 6 MW_e
- 1 plant of 4 MW_e
- And 1 plant of 3 MW_e.

The produced heat has internal application. The objective at the time of construction was to supply electricity only, and no infrastructure for heat was foreseen.

After the second telco, additional non-technical requirements were formulated by TGEC. On the basis of the input provided and some further thoughts, we proposed to collect the following non-technical information:

- Company size and size of relevant CHP/MCHP unit (in terms of turnover, staff)
- Location of company headquarters, representation in the Middle East and in Iran
- Technology focus of the company
- To what extent does the company license out technologies?

Finally, after the third telco, TGEC provided us with an additional list of technical information, see the table below. For the shortlisted suppliers and models, this information was provided to the extent companies were willing to share this information at that stage (see Appendix D).

Company	Electrical Power	Thermal Power	Total Thermal Power (50/30)	Total Thermal Power (80/60)	E Efficiency	T Efficiency	Tot Efficiency	Aux. Burner	Efficiency Over Boiler	Fuel Consumption	Retail Price	Maintenance Cost	Maintenance Period	Noise Level	Reliability	Total Sale No	Trading with Iran	Brand Popularity
	[kW]	[kW]	[kW]	[kW]	[%]	[%]	[%, LHV]	[kW]	[%]	[-]	[$]	[$]	[months]	[dBa]	[L/M/H]	[-]	[Y/N]	[L/M/H]

APPENDIX C. ECN Slide pack for discussion in teleconference No.5

ECN

Required specifications for CHP

- Data from original Quick Response Plan (Annex 2)

Parameter	Required specifications
Type (M)CHP	Reciprocating natural gas engine
Unit size[1] (as *agreed on with ECN*)	MCHP: 20-30 kWe CHP: 1-2 Mwe
Heat-to-power ratio	1.7-2.0
Grid specifications	230 V, 50 Hz
Allowable noise level	55 dB
Price range	800 – 1000 $/kWe

[1] Preferably one manufacturer for both ranges

ECN

Non-technical information

Task 1.3a: Additional non-technical information to be provided for the shortlisted companies.

On the basis of the input provided by Mrs. Aliakbari and some further thoughts, we propose to collect the following non-technical information:

- Company size and size of relevant CHP/MCHP unit (in terms of turnover, staff)
- Location of company headquarters, representation in the Middle East and in Iran
- Technology focus of the company
- To what extent does the company licence out technologies?

- Specification of scoring representation Middle East:
  - Low = no (service) dealer in the middle east
  - Medium = a (service) dealer in the middle east
  - High = a (service) dealer in Iran.

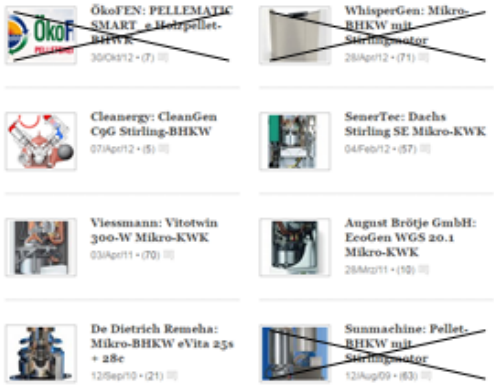
ECN

Stirling micro-CHP (mCHP)

(Add-on to original plan)

Longlist Stirling micro-CHP manufacturers (range <10 kWe)

ECN



LIST LIST2 LIST3

Shortlist micro-CHP manufacturers <10 kWe: technical information

ECN

Number	Manufacturer (+type)	P_e [kW]	P_{th} [kW]	H/P [/1]	η_e [%]	η_{th} [%]	η_{total} [%]	Noise level [dBa]
1	Cleanergy C9G	2-9	8-25	4-2.8	25	-	96[1]	<67
2	Senertec Dachs Stirling SE	1	3-23.8	3-23.8	-	-	97[1]	<45
3	Viessmann Vitotwin 300W/350F	0.6-1	3.6-26	6-26	-	-	107[2]	-
4	Brötje Ecogen WGS 20.1	0.3-1.0	5-20	5-20	-	-	107[2]	<45
5	Remeha eVita 25s/28c	1	3.7-27.4	3.7-27	-	-	107[2]	<47
6	Qnergy QB80	3-6.5	14-36.4	4.7-5.6	37	-	95[1]	<65
7								
8								
9								
10								

[1] HHV (Higher Heating Value)
[2] LHV (Higher Heating Value)

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Shortlist mCHP manufacturers <10 kWe: non-technical information

ECN

#	Manufacturer	Company size [employees/global net sales]	Location headquarter	Representation Middle-East [low, medium, high]	Technology focus	Trade
1	Cleanergy	medium sized / -	Sweden	low	CHP & CSP	-
2	Senertec	140 / €45.5 M.	Germany	Low	CHP	(external) dealers
3	Viessmann	11,500 / €2.2 bn.	Germany	High	Heating & cooling	(external) dealers
4	Brötje (**BDR Thermea**)	6,500 / €1.7 bn.	Netherlands	High	Heating & CHP	(external) dealers
5	Remeha (**BDR Thermea**)	6,500 / €1.7 bn.	Netherlands	High	Heating & CHP	(external) dealers
6	Qnergy (Ricor)	medium / -	Israel	High	CHP & cryogenic	-
7						
8						
9						
10						

ECN

micro & mini Gas Turbine

(Add-on to original plan)

Shortlist mini GT manufacturers <30 kWe: technical information

ECN

Number	Manufacturer (+type)	P_e [kW]	P_{th} [kW]	H/P [/1]	η_e [%]	η_{th} [%]	η_{total} [%]	Noise level [dBa]
1	MTT EnerTwin	1-3	6-15	6-3	15	75	90	55
2	Capstone Turbine C30	30	74	2.5	26	-	90	65
3	Bladon Jets (Genset!)	12	x	x	26.5	x	x	?
4								
5								
6								
7								
8								
9								
10								

[1] HHV (Higher Heating Value)
[2] LHV (Higher Heating Value)

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Shortlist mini GT manufacturers <30 kWe: non-technical information

ECN

#	Manufacturer	Company size [employees/global net sales]	Location headquarter	Representation Middle-East [low, medium, high]	Technology focus	Trade
1	MTT (EnerTwin)	small sized / -	Netherlands	low	CHP	?
2	Capstone Turbine	medium/ $133 M.	USA	high	CHP	(external) dealers
3	Bladon Jet	Small / -	UK	?	Electricity generation	?
4						
5						
6						
7						
8						
9						
10						

10

ECN

mini-CHP Gas Engines (MCHP)

ECN

Longlist: ~70 MCHP manufacturers (range 10-50kWe)

A A-TRON AISIN SEIKI ATN Hötzel	F frako power systems	L Lindenberg Anlagen lion energy	S Schmitt-Enertec Senergie SenerTec SES Energiesysteme Simple Energie Solvatherm Spanner Re² Steinecke Sunmachine
B Baxi Innotech Bosch KWK Systeme Bröte Buderus Button Energy	G Giese Green Energy Solutions greenPower	M Motoren-AT MWB	T TEDOM Tippkotter TOTEM Energy
C Capstone Ceramic Fuel Cells (CFCL) Cleanergy Cogenon COMUNA-metall	H HAASE Energietechnik Hexis Hoffer Blockheizkraftwerke Horstrup & Vogt. Rape Energy Hoval	O OkoFEN Otag	V Vaillant Viessmann (ESS Energie Systeme) Volkswagen
D Dreyer & Bosse	I intelli production	P Paradigma Deutschland proenvis	W Wätas WhisperGen Wolf Heiztechnik
E EAW Energieanlagenbau EC Power elcore Energietechnik Mandel energiewerkstatt E-quad Power Systems ETW Energietechnik ETZ Energietechnik	K Kirsch HomeEnergy Kraftwerk Kuntschar und Schlüter KW Energie	R Reindl Maschinenbau Remeha Riesser Brennstoffzellentechnik RMB/Energie	Y Yados Yanmar

Shortlist MCHP manufacturers 20-30 kWe

ECN

Number	Manufacturer (+type)	Number	Manufacturer (+type)
1	Vaillant (ecoPOWER)	11	KraftWerK (Mephisto)
2	Senertec (Dachs)	12	A-Tron (E20/43 E21/46)
3	Viessmann (Vitobloc)	13	KW Energie (Smartblock)
4	Yanmar (CP25WE)	14	2G Energy (G-box) *(also 1-2MWe)*
5	Tedom (Micro T) *(also 1-2MWe)*	15	EC Power (XRGI)
6	Buderus (Loganova)	16	SEF-Energietechnik (SEF G3000A)
7	RMB (Neotower)	17	Yados (KWK EG20)
8	Energiewerkstatt (ASV BHKW)	18	Hoval (PowerBloc EG 20)
9	EAW (EW V 20/30 S)	19	Remeha/2G Energy (ELW/G-box)
10	Giese (Energator)	20	ETZ (Muscetier)

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Shortlist MCHP manufacturers 20-30 kWe: tech. info for nos. 1-10

ECN

Number	Manufacturer (+type)	P_e [kW]	P_{th} [kW]	H/P [/1]	η_e [%]	η_{th} [%]	η_{total} [%]	Noise level [dBa]
1	Vaillant ecoPOWER 20.0	10-20	29-43	2.9-2.15	31.5	71	-	?
2	Senertec Dachs Pro 20	19.2[1]	42	2.2	32.9	70	94.7[2]	48
3	Viessmann Vitobloc EM-20	10-20	18-39	1.8-1.95	?	?	96.4[2]	?
4	Yanmar CP25WE	25[1]	38.7	1.55	33	51	-	62
5	Tedom Micro T30/T33	30/33	59/64	2/1.9	32.5	63	95.3	?
6	Buderus Loganova EN20/**21**	21.5[1]	40	1.85	33.1	61.5	94.6	?
7	RMB Neotower 20/21/25/**30**	15-30[1]	34-57	2.25-1.9	33	63	96.6	51
8	Energiewerkstatt ASV20/21/**30**	10-30	38-72	3.8-2.4	30	-	105[2]	<55
9	EAW EW K 20 S/**V 30 S**	30[1]	50	1.65	34.1	56.8	90.9	?
10	Giese Energator GB20/**GB30**	18-30	70.5	2.35	28.5	66.9	95.4	61

[1] Maximum rated output
[2] LHV (Higher Heating Value)

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Shortlist MCHP manufacturers 20-30 kWe: tech. info for nos. 11-20

ECN

Number	Manufacturer (+type)	P_e [kW]	P_{th} [kW]	H/P [/1]	η_e [%]	η_{th} [%]	η_{total} [%]	Noise level [dBa]
11	KraftWerK Mephisto G20+/G22/**G26**/G34	10-24	38-55	3.8-2.3	30.5	-	100.5[2]	?
12	A-Tron E20/43, **E21/46**	5-21	18-46	3.6-2.2	33	70	103[2]	50
13	KW Energie Smartblock 20/22/**33**	16-33	73.4	2.22	33.8	-	109[2]	48.5
14	2G Energy G-box **20**, 50	20[1]	44	2.2	32	70.4	102.4[2]	52
15	EC Power XRGI 20	10-20	40	4.0-2.0	32.7	63.4	96.1	?
16	SEF energietechnik SEF G3000A	25[1]	50	2.0	?	?	?	?
17	Yados KWK EG20	20	43	2.15	33	70	103[2]	?
18	Hoval PowerBloc EG **20**/43/50	5-20	18-43	3.6-2.1	?	?	?	?
19	Remeha/(*2G Energy*) **ELW 20**/50	10-20	20-43	2.0-2.1	32	73	105[2]	52
20	ETZ Muscetier NG20/**NG30**	20-30	45-63	2.25-2.1	28.8	62.5	91.3	<60

[1] Maximum rated output
[2] LHV (Higher Heating Value)

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Shortlist MCHP manufacturers 20-30 kWe – non-technical info (1-10)

ECN

#	Manufacturer	Company size [employees/global net sales]	Location headquarter	Representation Middle-East [low, medium, high]	Technology focus	Trade?
1	Vaillant	10,100 / -	Germany	Medium	Heating & cooling	(external) dealers
2	Senertec	140 / €45.5 M.	Germany	Low	CHP	(external) dealers
3	Viessmann	11,500 / €2.2 bn.	Germany	High	Heating & cooling	(external) dealers
4	Yanmar	15,000 / €7 bn.	Japan	Low	Diverse, i.a. engine technologies	(external) dealers
5	Tedom	498 / €57,000	Czech Republic	Medium	CHP & gas heat pumps	(external) dealers
6	Buderus	13,500 / €3.12 bn.	Germany	Low	Thermotechnology	-
7	RMB	55 / -	Germany	Low	CHP	-
8	Energiewerkstatt	Medium-sized / -	Germany	Low	CHP	(external) dealers
9	EAW EW	150 /	Germany	Low	Heating & cooling	-
10	Giese	33 / -	Germany	Low	CHP	(external) dealers

Shortlist MCHP manufacturers 20-30 kWe – non-technical info (11-20)

ECN

#	Manufacturer	Company size [employees/global net sales]	Location headquarter	Representation Middle-East [low, medium, high]	Technology focus	Trade?
11	KraftWerK	Small sized / -	Germany	Low	CHP	-
12	A-Tron	Small sized / -	Germany	Low	Heating & cooling	(external) dealers
13	KW Energie	+/- 30 / -	Germany	High	CHP	(external) dealers
14	2G Energy	580 / €7 bn.	Germany	Low	CHP	-
15	EC Power	Large sized / -	Denmark	Low	CHP	(external) dealers
16	SEF energietechnik	Small sized / -	Germany	Low	CHP	-
17	Yados	170 / -	Germany	Low	Heating & cooling	-
18	Hoval	1,400 / €319 M.	Germany	Medium	Heating & climate	(external) dealers
19	Remeha	550 / €300 M.	Germany	Low	Heating & cooling	-
20	ETZ Muscetier	Medium sized / -	Germany	Low	CHP	(external) dealers

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ECN

CHP

ECN

Longlist CHP manufacturers

Number	Manufacturer Gas Engines	Number	Manufacturer Gas Engines
1	Doosan	11	Zeppelin Power Systems
2	MAN	13	General Electric Jenbacher
3	Perkins	14	Dresser-Rand (Siemens)
4	Kawasaki Heavy Industries	15	Rolls-Royce MTU
5	Rolls-Royce Bergen-Engines	16	Cummins
6	Hyundai Heavy Industries	17	2G Energy *(also MCHP 20-30kWe)*
7	Fairbanks Morse	18	
8	Tedom *(also MCHP 20-30kWe)*	19	
9	Wärtsilä	20	
10	Caterpillar Energy Solutions	21	
11	MWM/Deutz (Caterpillar Energy Solutions)	22	

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ECN

Power range not matching the requirements

Number	Manufacturer Gas Engines	Unit	Power output
1	Doosan	MW_e	0.128 – 0.451
2	MAN	MW_e	0.37 – 0.58
3	Perkins	MW_e	0.3 – 1.0
4	Kawasaki Heavy Industries	MW_e	5 - 8
5	Rolls-Royce Bergen-Engines	MW_e	3.7 – 9.4
6	Hyundai Heavy Industries	MW_e	2.9 – 9.6
7	Fairbanks Morse (gas and dual-fuel engines)	MW_e	2.3 – 17.6
8			
9			
10			
11			

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Shortlist CHP manufacturers (range 1-2 Mwe)

ECN

Number	Manufacturer Gas Engines	Unit	Power output
1	Tedom Quanto D1200, D1600, D2000	MW_e	1.2/ 1.6/ 2.0
2	Wärtsilä Auxpac generating sets	MW_e	1.00/1.14/1.35/1.55/1.70/1.95
3	Caterpillar Energy Solutions (CAT CG170)	MW_e	1.20/1.56/2.00
4	Zeppelin Power Systems (CAT)	MW_e	1 - 2
5	Caterpillar Energy Solutions (MWM/Deutz) - TCG 2020 - TCG 2020 K	MW_e	1.20/1.56/2.00 1.000/1.125/1.500
6	General Electric Jenbacher, Waukesha	MW_e	1.067/1.137/1.426/2.004
7	Dresser-Rand (Siemens) Guascor HGM SFGM	MW_e	1.011/1.204/1.308
8	Rolls-Royce MTU, Gas genset	MW_e	1.012/1.286/1.523/1.718/1.999
9	Cummins Lean burn gas generator, CHP	MW_e	1/1.16/1.20/1.40/1.54/1.75/2
10	2G Energy Avus 1200c, 1500c, 2000c	MW_e	1.2/1.56/2.0

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Shortlist CHP manufacturers (range 1-2 Mwe)

ECN

#	Manufacturer	Company size [employees/global net sales]	Location headquarter	Representation Middle-East [low, medium, high]	Technology focus	Trade?
1	Tedom	498 / €57,000	Czech Republic	Medium	CHP and gas heat pumps	(external) dealers
2	Wärtsilä	18,000 / €5.0 M.	Finland	High	Liquid and gas fueled power generation	(external) dealers
3-5	Caterpillar Energy Solutions	1300 / €347 M.	Germany	High	(bio)gas and diesel engine technology	(external) dealers
6	General Electric	38,000 / €23.90 bn.	USA	Medium	engine technology	-
7	Dresser-Rand (Siemens)	+ 11,000 / -	USA	Low	engine technology	-
8	Rolls-Royce	10,700 / €16.6 M.	Germany	High	CHP	(external) dealers
9	Cummins	55,200 /	USA	Low	engine technology	(external) dealers
10	2G Energy	580 / €186.6 M.	Germany	Low	CHP	-

ECN

From longlist to short list

- MCHP and CHP have their own distinct market and manufactures
  - MCHP and CHP have their own distinct market and manufactures
- Based on the non-technical information, '*the medium and high representation in the Middle East*' categories are sufficient.
  - MCHP: High: Viessman, KW Energie. Medium: Vaillant, Tedom, Hoval.
  - CHP: High: Rolls-Royce, Wärtsillä, Caterpillar Energy Solutions. Medium: Tedom, General Electric.

APPENDIX D. Technical details of shortlisted companies and models

D.1: Stirling micro-CHP suppliers and models

Company	Electrical Power	Thermal Power	Total Thermal Power (50/30)	Total Thermal Power (80/60)	E Efficiency	T Efficiency	Tot Efficiency	Aux. Burner	Efficiency Over Boiler	Fuel Consumption	Retail Price	Maintenance Cost	Maintenance Period	Noise Level	Reliability	Total Sale No	Trading with Iran	Brand Popularity
	[kW]	[kW]	[kW]	[kW]	[%]	[%]	[%LHV]	[kW]	[%]	[-]	[$]	[$]	[months]	[dBa]	[L/M/H]	[-]	[Y/N]	[L/M/H]
BDR Thermea/Remeha (eVita 28c)	1	5	4.1-27.4	3.7-24.9	15	*92,4*	107,4	*22,4*	?	?	10,750		12	<47	H		Y	H
Viessmann (Vitotwin 300-W)	0.6-1	3.2-5.3	3.6-26	3.2-24.6	15	*92*	107	*20,7*	?	?	13,500		12	?	H		Y	H

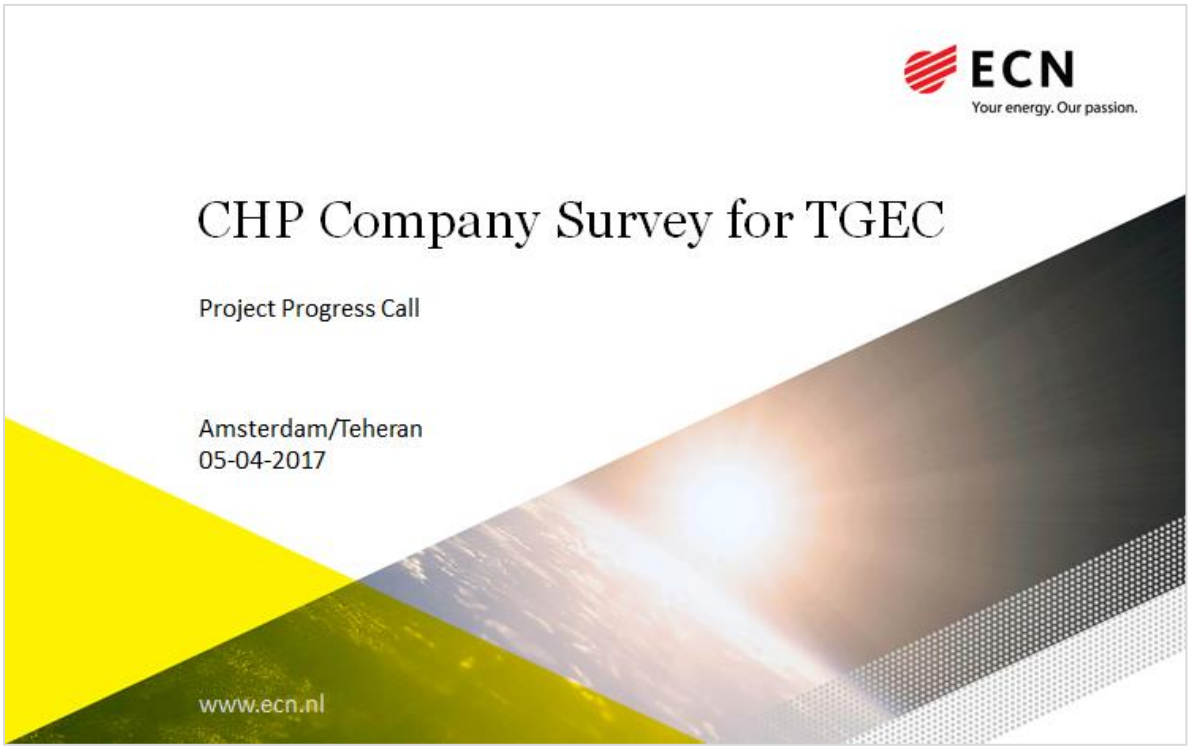
D.2: Gas turbine mini-CHP suppliers and models

Company	Electrical Power	Thermal Power	E Efficiency	T Efficiency	Tot Efficiency	Efficiency Over Boiler	Fuel Consumption	Retail Price	Maintenance Cost	Maintenance Period	Overhaul Period	Noise Level	Reliability	Total Sale No	Trading with Iran	Brand Popularity
	[kW]	[kW]	[%]	[%]	[%, LHV]	[%]	[-]	[$]	[$]	[hours]	[hours]	[dBa]	l/m/h	[-]	[Y/N]	[L/M/H]
MTT EnerTwin	1-3	6-15	15	*75*	90		0.84-1.87 nm^3/h	16,000				55				
Capstone Turbine C30	30	*74*	26	*64*	90		13.8 MJ/kWh					65		8500+		
Bladon Jet	12	-	26,5	-	-					8,000+	25,000	<65				

D3: Combustion engine (mini)CHP suppliers and models

Company	Electrical Power	Thermal Power	E Efficiency	T Efficiency	Tot Efficiency	Aux. Burner	Efficiency Over Boiler	Fuel Consumption	Retail Price	Maintenance Cost	Maintenance Period	Noise Level	Reliability	Total Sale No	Trading with Iran	Brand Popularity
	[kW]	[kW]	[%]	[%]	[%, LHV]	[kW]	[%]	[kW]	[$]	[$]	[months]	[dBa]	[L/M/H]	[-]	[Y/N]	[L/M/H]
Vaillant (ecoPOWER 20.0)	10-20	29-43	31,5	71	102,5		-	42,0				?				
Viessmann (Vitobloc EM-20)	10-20	18-39	?	?	96,4		-	40,5				?				
Yanmar (CP25WE)	25	38,7	33	51	84		-	75,8				?				
Tedom (Micro T30)	30	69	32	73,6	105,6		-	93,8				?				
Remeha/(2G Energy) ELW 20	10-20	20-43	32	73	105		-	41,0				52				
Buderus Loganova EN20	19	36	34	64,3	98,3		-	56				?				

APPENDIX E. ECN Slide pack for discussion in teleconference No. 6



ECN

Selected manufactures/suppliers

- Based on the last progress call the following mCHP companies have been surveyed, concerning the following systems:

Supplier	Technology, model		
	Stirling CHP	Combustion engine CHP	Turbine CHP
Remeha	eVita 28c	ELW 20	
Viessmann	Vitotwin 300-W	Vitobloc EM-20	
Yanmar		CP25WE	
Tedom		Micro T30	
MTT			Enertwin

ECN

Remeha – Survey outcome

- Contact person: Marco Bijkerk (Manager Innovative Technologies)
- Remeha is interested in setting up contact with TGEC.
  - Mr. Bijkerk forwarded the request to the unit Export of Remeha. Our contact person there will be Astrid Olthuis (Export Managar). Mr. Bijkerk will stay in charge concerning technical issues.
  - Spec sheet for Stirling engine (eVita) and gas engine (ELW20-43) sent to Mr. Bijkerk. They are not totally comfortable by providing all the requested data at this stage of the process. Prefers to wait when direct contact between TGEC and Remeha is in place.

BDR (Remeha) - non-technical information

- BDR in total 6,500 employees, 3 departments Global total sales € 2.7 billion.
- Headquarter Apeldoorn, Netherlands. Operate in more than 70 countries worldwide. High representation Middle east;
- BDR owns and sells among others: Brötje, Remeha, Baxi, DE Dietrich, Chappée and Baymark
- Technology focus: high efficiency boilers. Portfolio of: low carbon heating technologies including biomass, solar thermal, heat pumps and micro-CHP.
- Trade via (external) dealers (qualified sales and service partner organizations).

Remeha eVita 25s/28c

	Remeha eVita 25s Solo	Remeha eVita 28c Kombi
Anwendungsbereich	Einfamilienhäuser, Gewerbebetriebe	Einfamilienhäuser, Gewerbebetriebe
Brennstoff	Ergas H/L	Ergas H/L
Brennstoffverbrauch	k.A.	k.A.
Geräuschniveau	47 db(A)	47 db(A)
Motor	Freikolben - Stirlingmotor	Freikolben - Stirlingmotor
Hubraum	k.A.	k.A.
Drehzahlbereich	k.A.	k.A.
Emissionswerte NOx	k.A.	k.A.
Emissionswerte CO	k.A.	k.A.
elektrische Leistung (Strom)	max. 1,0 kW	max. 1,0 kW
thermische Leistung (Wärme)	3,8 - 26,3 kW modulierend (bei 50/30°C; davon Zusatzbrenner 18,0 kW)	3,8 - 28,0 kW modulierend (bei 50/30°C; davon Zusatzbrenner 18,0 kW)
Wirkungsgrad elektrisch	ca. 14%	ca. 14%
Gesamtwirkungsgrad	k.A.	k.A.
Abmessungen (BxHxT)	49,0 x 91,0 x 47,1 cm	49,0 x 91,0 x 47,1 cm
Platzbedarf (BxT)	Wandmontage!	Wandmontage!
Gewicht	110 kg	120 kg
Vorlauftemperatur	k.A.	k.A.
Rücklauftemperatur	k.A.	k.A.
Stromanschluss	230 V	230 V

ECN

Remeha ELW 20-43

Remeha ELW 20-48	Technische gegevens
Elektrisch vermogen	10 tot 20 kW (regelbaar)
Elektrisch rendement	32,0 % (bij 20 kW)
Rendement generator	92,3% (bij max. 70°C)
Thermisch vermogen	20 tot 43 kW
Thermisch rendement	73 %
Totaal rendement	105,0 %
Max. geluidsdrukniveau	52,0 dB (A)
Brandstof	Aardgas H, L en vloeibaar gas
Afmeting (incl. extensies) L/B/H	ca. 1.625 / 1.023 / 1.222 mm
Inbouwafmeting L/B/H	ca. 1.200 / 735 / 939 mm
Nominaal motortoerental	1.500 toeren per minuut
Koelwatertemperatuur	minimum 80°C/82°C maximum 88°C

ECN

Viessmann

Viessmann – Survey outcome

- Contact person: Jan Willem van de Velde - Strategy & Business Development Manager
  - Viessmann is interested in setting up business with Iran, however: Mr. Van de Velde has to contact the head office (Germany) first.
  - Also, he thinks Viessmann might already have a supplier in Iran, or is in the process of obtaining one.
  - Agreed to contact me when he has more information on the topic
- No more contact after first telephone call

Viesmann - non-technical information

- 2015: in total 11,500 employees, 3 departments (relevant: Heating Systems division). Global total sales € 2.2 billion.
- Headquarter Allendorf, Germany
  High representation Middle east; Office in Tehran, Iran (Pouya Installation Institute; external dealer).
- Technology focus: heating & cooling technologies.
- Trade via (external) dealers (qualified sales and service partner organizations).

ECN

Viessmann Vitotwin 300W/350F

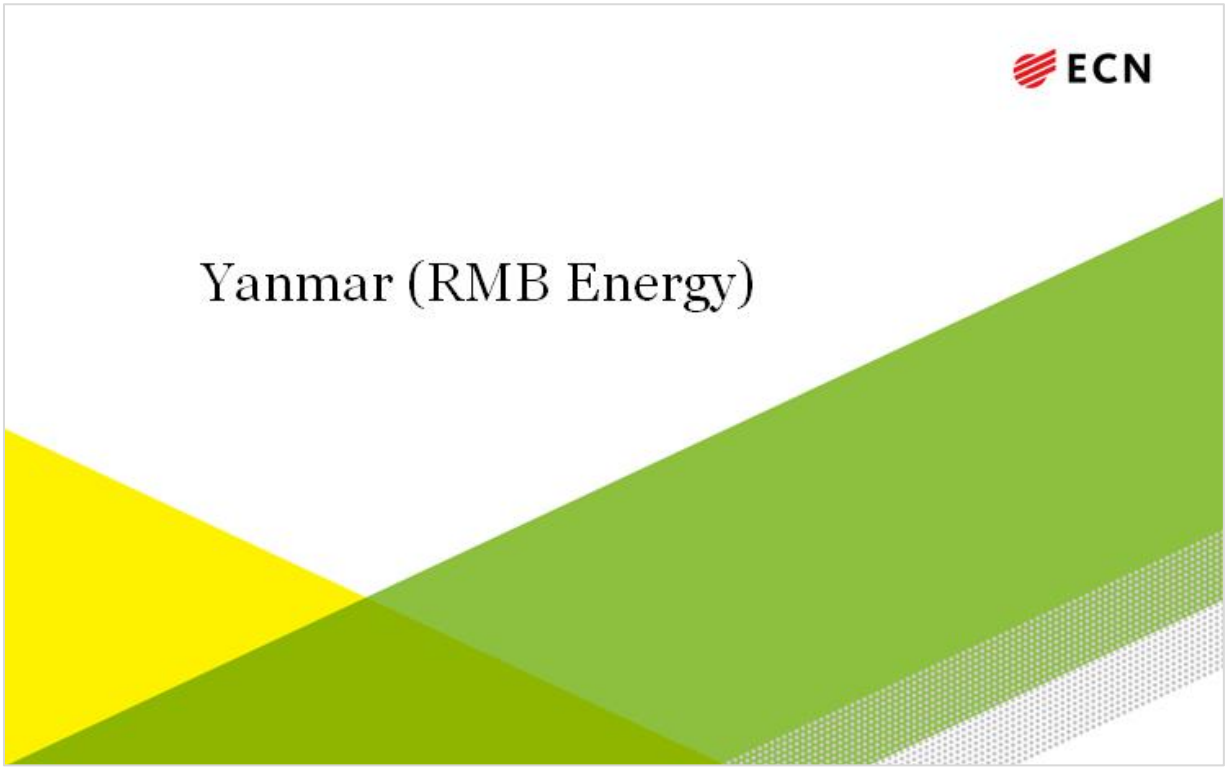
Nenn-Wärmeleistung (50/30 °C)	kW_{th}	3,6 – 26
Nenn-Wärmeleistung (80/60 °C)	kW_{th}	3,2 – 24,6
Elektrische Leistung	kW_{el}	1,0
Gesamtwirkungsgrad	%	96 (H_s)/107 (H_i)
Abmessungen Vitotwin 350-F		
Länge (Tiefe)	mm	600
Breite	mm	600
Höhe	mm	2030
Abmessungen Vitotwin 300-W		
Länge (Tiefe)	mm	480
Breite	mm	480
Höhe	mm	900
Gewicht Vitotwin 350-F	kg	260
Gewicht Vitotwin 300-W	kg	125
Nennspannung	V	230
Nennfrequenz	Hz	50

ECN

Viessmann Vitobloc200 EM-20/39

Gasmotoren op aardgas

Warmtekrachtkoppelingsmodule Vitobloc 200 Module	Cilinderaantal	Vermogens[1] [kW] elektrisch[2] cos φ = 1,0	thermisch[3] ± 5 %	Gasverbruik [kW] DIN ISO 3046 ± 5 %	Type
EM-5	R3	5,5	13,5	20	Lambda = 1[4]
EM-20/39	R4	20	39	62	Lambda = 1[4]
EM-50/81	R4	50	81	145	Lambda = 1[4]
EM-70/115	R6	70	115	204	Lambda = 1[4]
EM-140/207	R6	140	207	384	Lambda = 1[4]
EM-199/263	R6	199	263 + 20	538	Kleine turbomotor met mengselkoeler[5]
EM-199/293	R6	199	293	553	Kleine turbomotor met mengselkoeler[5]
EM-238/363	V12	238	363	667	Lambda = 1[4]
EM-363/498	V12	363	498	960	Kleine turbomotor met mengselkoeler[5]
EM-401/549	V12	401	549 + 26	1053	Kleine turbomotor met mengselkoeler[5]



ECN

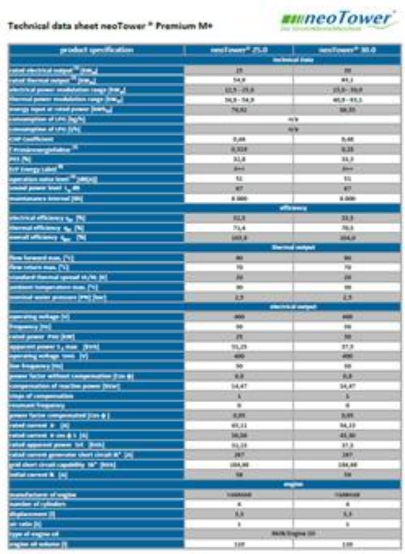
RMB Energy – Survey outcome

- Contact person Yanmar: Yosuke Tajima - Manager Energy Systems
- Yanmar Regional head quarters for Europe are in the Netherlands, however in 2015 CHP business is moved to RMB Energy (Germany). CHP systems of RMB go by the name Neotower.
- Contact person RMB: Jürgen Zastrow - Head of Sales
  - RMB is interested in setting up buisiness with TGEC
  - People from Iran showed interest in RMB during ISH (Frankfurt Messe (12-16/3)
  - Sent information concerning company profile of RMB and technical specifications of their Neotower.

RMB - non-technical information

- 2017: in total 61 employees. Global total sales € ?? million (380 units p.a.)
- Headquarter *Ramsloh*, Germany.
  Representation Middle east; RMB none, Yanmar unknown
  Dealer location in Middle east; RMB none, Yanmar unknown
- Technology focus: Production and distribution of cogeneration units, with engines from Yanmar, Toyota
- Sales channel: multi-level distribution
- For business with Iran RMB has to discuss with Yanmar

RMB neoTower M+



ECN

Tedom – Survey outcome

Contact persons

- Mr. Petr Dolezal - Regional Sales Manager (TEDOM)
  - No reaction by phone and mail
- Mr. Pierre Yves Pirlot - International Development Manager (ESPY)
  - Contacted by telephone and afterwards by e-mail. Has committed to forward the request to the right delegate witin Tedom. Until now, no reaction.
- Mr. Luboš Nedvědický – Business Development (TEDOM)
  - Interested in setting up business with Iran
  - Sees potential for their products in Iran
  - ECN reqested additonal information on company profile and technical specifications

ECN

TEDOM- non-technical information

- 2014: in total 498 employees, global total sales € 57.000
- Headquarter Třebíč, Czech Republic.
  Medium representation Middle east; dealer location in Israel.
- Technology focus: CHP and gas heat pumps
- Licensing in terms of (external) dealers.

ECN

TEDOM Micro T30

Performance possibilities of TEDOM CHP Units

CHP Unit type	Fuel			Design			
	Natural gas	Biogas	LPG	Open Module	Sound Enclosure	Container	Modular design
Micro T7	✔		✔		✔		
Micro T30	✔	✔	✔		✔		
[illegible]	✔				✔		
Micro T50	✔				✔		

Basic Technical Data – **NATURAL GAS**

CHP Unit type	Electrical Output (kW)	Heat Output (kW)		Electrical Efficiency (%)	Heat Efficiency (%)		Total Efficiency (%)		Power input in fuel (kW)
		standard	increased [1]		standard	increased [1]	standard	increased [1]	
Micro T7 [1]	7	17,2	19,8	27,0	66,3	76,4	93,3	103,4	25,9
Micro T30 [2]	30	59,4	69	32,0	63,3	73,6	95,3	105,6	93,8
Micro T33 [2]	33	63,7	74,2	32,5	62,8	73,1	95,3	105,6	101,5
Micro T50 [2]	48	91,0	106,6	32,5	61,3	72,2	94,1	104,7	148

ECN

MTT – Survey outcome

- Contact person: Willy Ahout (CEO)
- Positive on setting up business with Iran
- Market
  - 60% domestic, 40% utility. Average gas use 7000 m3/yr and above
- Cost price
  - Installed price 10.000 euro (quantity 5000-7000 units), without buffer/boiler
- Future technical plans
  - Air bearings, oil free systems, also improves efficiency

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MTT – Survey outcome

- Field testing
  - First phase: 30 systems in field test with togehter 15,000-20,000 operational hours
  - Second phase: started in 2016
  - All systems heat demand driven
- Maintenance
  - Small maintenace after 5,000 running hours
  - Large maintenace after 10,000 running hours (oil change 4 litres)
  - Oil consumption 0,5 litre/5,000 hours
  - Maintenance costs 6-9 eurocent/kWh_e
- From summer 2017 small number of systems available to the market

ECN

MTT - non-technical information

- Small-sized company, founded in 2003
- Headquarter in Eindhoven, Netherlands. Offices in Europe and Russia
  No representation Middle east
- Technology focus: Turbine mCHP
- Trade: via (external) dealers (qualified sales and service partner organizations).

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MTT EnerTwin

ENER TWIN heat & power

Specifications

		Max.	Min.	
Performance at ISA *	Net electric power **	3.0	1.0	kW
	Net thermal power	15 ***	6.0	kW
	Power to heat ratio at max power	20		%
	Net grid output efficiency (electrical)	15		%
	Total efficiency	90 ***		%
	Jaw EcoDesign (EU 813/2013)	> 100		%
	Rotor speed	240.000	180.000	rpm
	Fuel flow (H gas, 38.5 MJ/nm³)	1.87	0.84	nm³/h
Fuel	Natural gas H, E and L			
Operating conditions	Ambient air pressure	0.8 .. 1.1		bar
	Inlet air temperature	-20 .. 40		°C
	System room temperature	5 .. 40		°C
Heating system	Water flow rate	3 .. 21		l/min
	Water return temperature	5 .. 60		°C
	Water out/buffer vessel temperature	5 .. 80		°C
	Water pressure	1.5 .. 3		bar
Maintenance	Service interval	1 / 5000		year/ hours
Emissions	NO_x	< 27		ppm @ 15% O_2
	CO	< 50		ppm @ 15% O_2
	CO_2 savings	3 - 6 ****		tons/year
	Noise	55		dB(A) 1m

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Thank you for your attention

ECN
Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 ZG Petten
The Netherlands

T +31 88 515 49 49
F +31 88 515 44 80

info@ecn.nl
www.ecn.nl

CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

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The Climate Technology Centre and Network (CTCN) fosters technology transfer and deployment at the request of developing countries through three core services: technical assistance, capacity building and scaling up international collaboration. The Centre is the operational arm of the UNFCCC Technology Mechanism, it is hosted and managed by the United Nations Environment and the United Nations Industrial Development Organization (UNIDO), and supported by more than 300 network partners around the world.

Climate Technology Centre and Network
UN City, Marmorvej 51
DK-2100 Copenhagen, Denmark
+45 4533 5372
www.ctc-n.org
ctcn@unep.org

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UN environment
United Nations Environment Programme

United Nations Framework Convention on Climate Change

UNIDO
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

European Commission

Norwegian Ministry of Foreign Affairs

UDENRIGSMINISTERIET DANIDA

Canada

METI
Ministry of Economy, Trade and Industry

環境省
Ministry of the Environment
Government of Japan

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic A
Education and Research EAER
State Secretariat for Economic Affairs SECO

Ministry of Science, ICT and Future Planning

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

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German government