

## PT Pertamina Hulu Energi West Madura Offshore (PHE WMO)

*Achieved 10.2% energy efficiency and USD 931,986 cost saving through ISO 50001:2018 implementation since 2020*



Figure 1 PHE WMO Production Facilities

Case Study Snapshot	
<b>Industry</b>	Oil and gas
<b>Product/Service</b>	Oil and gas
<b>Location</b>	Gresik, East Java - Indonesia
<b>Energy performance improvement percentage</b> (over the improvement period)	10.2% improvement over 1 years (2020)
<b>Total energy cost savings</b> (over the improvement period)	USD 931,986
<b>Cost to implement Energy Management System (EnMS)</b>	USD 48,045
<b>Total energy savings</b> (over the improvement period)	295,713 GJ
<b>Total CO<sub>2</sub>-e emission reduction</b> (over the improvement period)	48,095 TonsCO <sub>2</sub> eq

### Organization Profile / Business Case

PHE WMO is an Indonesia’s national oil and gas company whose working area is in Zone 11 Region 4 PT Pertamina Hulu Energi (PT PHE). It operates in upstream oil and gas at West Madura Offshore (WMO) Block located between Madura Island and Bawean Island with Onshore Receiving Facility at Gresik, East Java. It produced 4,403 BOPD oil and 65.44 MMSCFD gas in average in 2021 and contributed 0,92% and 1,8% to Indonesia’s crude oil production and gas production respectively. It successfully maintains environmental performance during uncertainty due to natural decline of production and significant change in its holding company’s organization including SCM, finance, legal and HR division.

In oil and gas industry, PHE WMO is competing with other oil companies both national and multinational oil companies. To remain ahead in the competition, PHE WMO consistently implements best practice available to the extent it is reasonably practicable. One of them is implementation of Energy Management System based on ISO 50001:2018 since 2020. Milestone of implementation of EnMS in PHE WMO is provided in Figure 2.

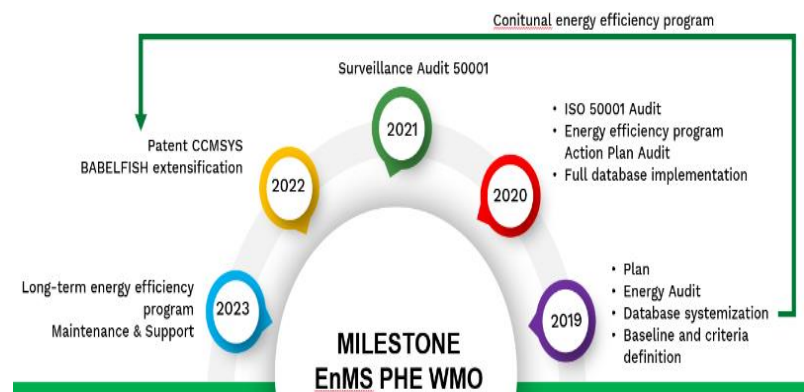


Figure 2 Milestone EnMS PHE WMO

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PHE WMO consumes more than 1 million GJ of energy annually, therefore it implements ISO 50001:2018. Moreover, implementation of ISO 50001:2018 ensure company's compliance to regulation and cost saving through energy efficiency.

Significant Energy Use is gas fuel that accounted for more than 90% of total energy consumption. Positive impacts of ISO 50001 implementation is maintaining energy intensity as much as 10% (2019) and 11% (2020) during which oil and gas production declined significantly. The achievement is obtained through targeted energy efficiency innovation such as energy efficiency in Turbine Compressor with **Turbo-CTAR, X-Treme, El-Barkah** innovations and in Turbine Generator with **SAKERA dan SAJANE** innovations. Those innovations have been registered in national patent and received multiple awards nationally in Indonesia.

In addition, PHE WMO vision is “towards world class oil and gas company” and implementation of Energy Management System ISO 50001 plays significant role in achieving the vision. PHE WMO is committed to produce quality product in a safe and environmentally responsible manner. Therefore, implementation of ISO 50001 is supported by existing implementation of other international management system standard such as ISO 9001, ISO 14001 and ISO 45001.

## “Implementation of ISO 50001:2018 ensure company's compliance to regulation and cost saving through energy efficiency”

— Muhamad Arifin – PHE WMO General Manager

### Business Benefits

Before ISO 50001 is implemented, PHE WMO understood that investment has to be made to save its energy beyond business-as-usual approach. The investment includes ISO 50001 system development; internal staff time to develop, implement the EnMS and prepare for external audit; personnel certification; ISO 50001 certification as well as investment for energy efficiency program. In 2020, PHE WMO invested total of USD 48,045 to run its EnMS ISO 50001 initiatives. Successful implemented ISO 50001 saved energy cost and other benefits that accounted more than total investment.

### Tangible Benefits:

**Energy cost saving:** implementation of ISO 50001 saved energy cost as much as USD 931,986 based on improved energy performance by comparing baseline and actual energy performance provided in Cumulative of Sum (CUSUM) as shown in Figure 3. Baseline period was set in December 2019 – September 2020 and energy driver identified as gas production and oil production. Year 2020 is selected as baseline period since it represents normal period of production.

**Energy Consumption Reduction:** PHE WMO consumes significant amount of energy in its operational activities. Energy sources are natural gas (own use), biodiesel and imported electricity from power company. Energy consumption of PHE WMO from 2019 to 2021 is shown in Figure 4 below. Implementation of Energy Management System is proven to reduce energy consumption during 2019-2021 period with very substantial reduction of 476,911 GJ equivalent with 23% total energy reduction.

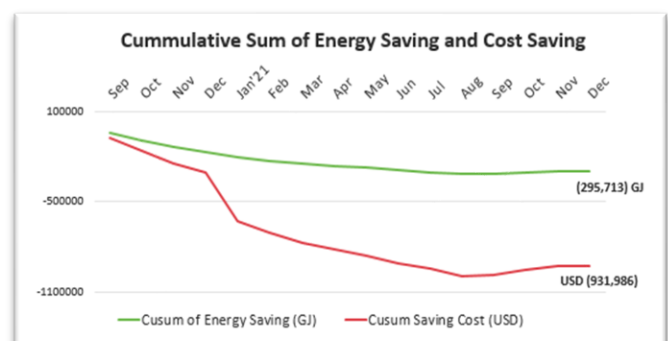


Figure 3 Cusum energy saving and cost saving vs price goods

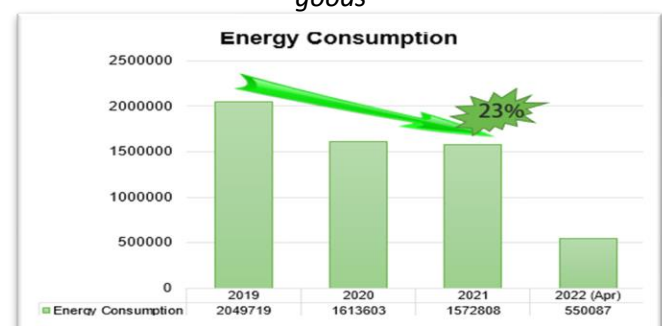


Figure 4 PHE WMO energy consumption

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**Renewable Energy Use:** As part of initiatives to achieve energy efficiency, PHE WMO installed solar cell for outdoor lighting in offshore and onshore operation facilities. Application of solar cell is company’s commitment to achieve energy target as well as contribute to Government of Indonesia’s achievement of Sustainable Development Goal’s (SDG’s) Number 7 is Affordable and Clean Energy. PHE WMO produce 314 GJ annually from its solar cell program.

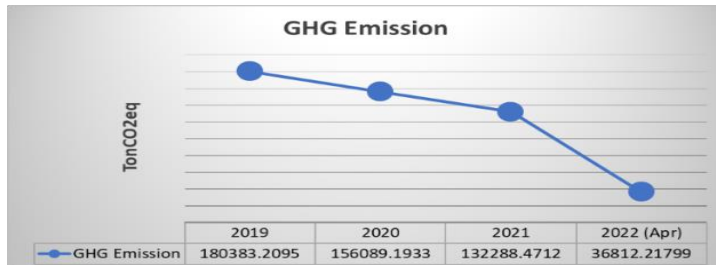


Figure 5 GHG emission reduction PHE WMO

**GHG Emission reduction:** Implementation of ISO 50001 has significant contribution to company’s emission reduction. Based on emission calculator referring to Ministry of Environment No 12 Year 2012, PHE WMO has reduced its carbon emission as much as 48,095 TonCO2eq during 2019 to 2021 period which is equivalent with 26% reduction.

## Intangible Benefits:

Indirect benefits of EnMS implementation for PHE WMO are:

- Successful implementation of EnMS has put PHE WMO as benchmark for other Pertamina’s Companies
- Sustainability report wherein energy performance improvement is part of good practice reported
- Motivates its employee to propose innovative energy efficiency program with estimated of 3,800 man-hours involved every year
- Winner of National Energy Efficiency Award 2021
- Gold PROPER Rating (the highest rating) of environmental performance rating from Ministry of Environment
- Gold Medal in Continuous Improvement Program with energy efficiency innovation namely X-Treme and PERHIJO
- Installation of solar cell & wind turbine with a capacity of 1.6 KW/day at the Marine Tourism Park
- Meet the Key Performance Indicators (KPI) in Sustainable Emission Reduction of 0.25% annually
- Emission reduction of 26% is direct contribution to the government’s target to reduce GHG with a target of 29% by 2030 in accordance with the Nationally Determined Contribution (NDC).

## Plan

### Top Management Commitment

PHE WMO is committed to implementing ISO 50001. This commitment is stated in the Health, Safety, Environmental Protection & Security (K3LL & Security) Policy. The contents of the policy indicate that PHE WMO “implements an Energy Management System and strives to optimally in efficient and responsible energy consumption”. In addition, PHE WMO also established Energy Management Policy in which energy efficiency target is set 5% reduction from 2020 to 2025 or the equivalent of 0.8% annually. PHE WMO also has a specific policy with emission reduction target of 29% by 2030. Top level management is also committed to providing resources in the form of budgets to improve personnel competence and energy efficiency programs or innovations with a total of USD 2,367,320 as can be seen in Figure 6.

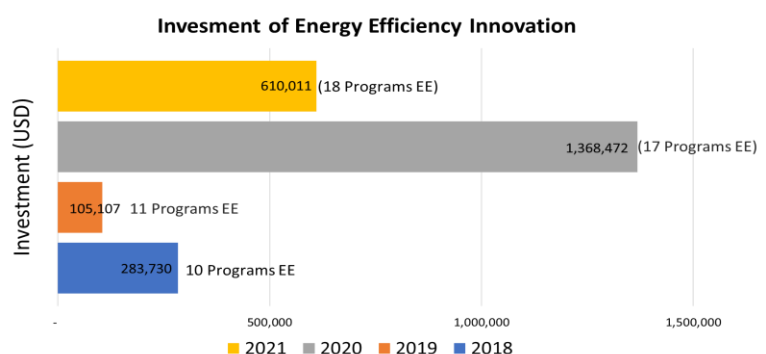


Figure 6 Investment for energy innovation

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## Energy Review, Baseline and EnPI

PHE WMO has determined Significant Energy Used (SEU) from energy review. SEU in PHE WMO is gas fuel accounted for more than 90% of total energy. Gas Fuel is used as an energy source for Gas Turbine Compressor (GTC), Gas Turbine Generator (GTG) in PPP area and PHE5 Area as well as reboiler in ORF.

PHE WMO has defined types of Energy Performance Indicators (EnPI) and Energy Baseline (EnB) for each level referring to ISO 50006:2014 as shown in Figure 7.

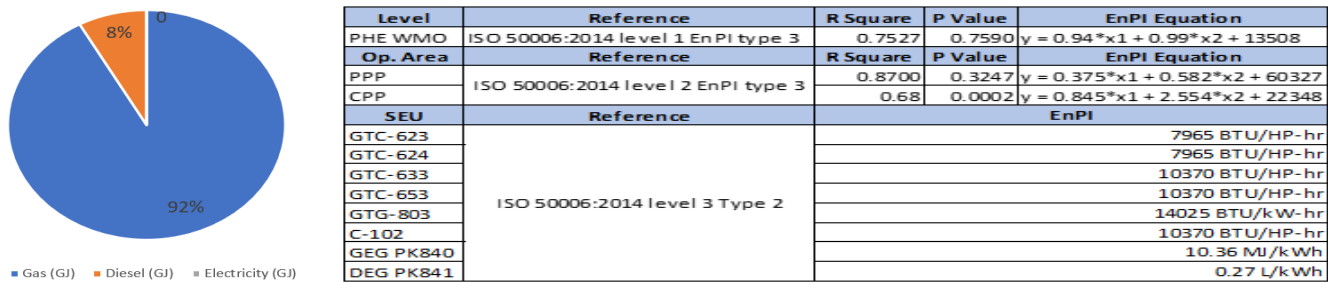


Figure 7 PHE WMO SEU and Baseline equation & EnPI

## Objective Target

The energy saving target has been set at 5% or equivalent to 0.8% annually or equivalent to 52,337 GJ until 2025 which is stated in the energy efficiency management policy approved by top management. Top Management has also target to maintain ISO 50001 in 2023.

## Action Plan

To achieve energy efficiency targets, PHE WMO identified energy saving opportunities through third party energy audits, internal auditors who are nationally certified, as well as any competent parties in their respective fields. These energy saving opportunities is evaluated and ranked to determine priority and timeline of implementation. Energy saving opportunities are also ranked based on several criteria, such as potential cost savings, required investment and investment payback period (simple payback) as shown in Figure 8. Based on the ranking evaluation with those criteria, PHE WMO defined strategic plan of energy management program for 4 years of implementation as shown in Figure 9.

Criteria	Rating			
	1	2	3	4
Annual Cost Saving	< Rp 100 million	Rp 100 million - Rp 500 million	Rp 500 million - Rp 1 billion	> 1 billion
Investment	> Rp 1 billion	Rp 500 million - Rp 1 billion	Rp 100 million - Rp 500 million	< Rp 100 million
Simple Payback	> 3 years	13 months - 3 years	6 - 12 months	< 6 months

Figure 9 Evaluation and ranking criteria

No	Programme	2020	2021	2022	2023	Cons energy (GJ)	Total Investment (\$)	Total Saving (\$)	Category
1	Implementation of ISO 50001:2018					-	19416.41	0.00	High Cost
2	External energy audit					-	14562.31	0.00	High Cost
3	Wind Turbind installation for alternative energy on production facilities					4500	45051.29	35417.24	High Cost
4	Green building certification					72	34654.84	0.00	High Cost
5	Temperature setting of Air Conditioner at ORF building					150	1039.00	350.00	Medium Cost
6	Heat Loss Reducer for Gas Turbine Fuel Gas					400	5545.24	10333.28	Medium Cost
7	Energy Mutualism between Oil and Gas treatment					50000	15596.00	2921351.68	High Cost
8	Water vapor handling from TGRS (Den Gering)					2000	65602.90	244746.66	High Cost
9	Performance improvement of Gas Turbine Compressor (Turbo CTAR)					78840	42802.34	1106913.44	High Cost
10	Performance improvement of Gas Engine Generator (SAKERA)					1526	15981.81	194476.98	High Cost
11	optimization of FSO Abherka Genset					1387	0.00	93947.47	No Cost
12	Performance improvement of Diesel Engine Generator (SAJANE)					13125	10397.33	143653.40	Medium Cost
13	Performance improvement of Gas Turbine Compressor (X-Trem)					15261	53079.07	398947.20	High Cost
14	Increasing production trough MTG as ESP Genset					4560	41589.32	11700.79	High Cost
15	Optimization of PHE 40 ESP Genset					1000	0.00	43838.61	No Cost
16	Replacement of E-Forklift to reduce emission					360	17328.88	5972.70	High Cost
17	Replacement of TL Light to LED for energy saving					1608	9435.58	15586.18	Medium Cost
18	Hybrid Energy using photovoltaic system					150	5072.57	6797.47	Medium Cost
19	Replacement refrigerant R-410a to R407c for less emission					1030	7971.91	75901.54	Medium Cost
20	Taxi to Shuttle Boat management System (TTS)					12000	0.00	2269178.83	No Cost
21	Improvement of reliability PHE 30 Subsea cable (Crabs)					360	36978.88	2972.14	High Cost
22	Rescheduling Crew Change Action to reduce vessel fuel (Recreation)					890	0.00	132353.41	No Cost
23	Monitoring control system for Gas Turbine Compressor (El-Barkah)					50000	0.00	172383.12	No Cost
24	Solar Cell for Saving Energy Alternative (Social) for community development					150	178.00	250.00	Medium Cost

Figure 8 Strategic plan of energy management program

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## Do, Check, and Act

### Implementation Action Plan

No.	Energy Conservation	Location	Energy Saving per Year						Total Cost Saving (USD)	Investment (USD)	Payback (Year)
			2019		2020		2021*				
			Energy Saving (GJ)	Cost Saving (USD)	Energy Saving (GJ)	Cost Saving (USD)	Energy Saving (GJ)	Cost Saving (USD)			
<b>A Production Process</b>											
1	Heat Loss Reducer for Gas Turbine Fuel Gas**	PPP	415,8	9.068	476,6	10.333	498,8	10.893	30.295	5.517,24	0,54
2	Energy Mutualism between Oil and Gas treatment**	PPP	59.052,8	1.287.813	134.726,2	2.921.352	129.293,7	2.823.897	7.033.061	15.517,24	0,01
3	DenGering**	ORF	12.164,2	93.921	31.047,0	244.747	31.637,1	212.518	551.185	65.271,63	0,27
4	Turbo Clear**	PPP	17.109,9	132.108	140.416,0	1.106.913	191.586,2	1.286.955	2.525.976	42.586,21	0,04
5	Sakera (DEG-840)**	CPP/PHE-5	3.100,8	44.763	11.935,0	194.477	7.368,2	168.004	407.243	15.901,10	0,08
6	Optimasi Genset Abharka**	FSO Abharka	4.060,4	58.615	5.765,6	93.947	4.967,6	113.268	265.830	-	-
7	Sajane (DEG-841)**	CPP/PHE-5			8.816,0		4.249,2		-	10.344,83	0,07
8	X-Treme**	PPP			50.607,9		101.778,1		-	52.811,03	0,13
9	Omnibus - Operating Micro Turbin Generator Behind Utilization of Electrical	PHE-38B			718,1		3.141,8		-	41.379,31	3,55
10	Optimasi Genset ESP PHE 40**	PHE-40					1.922,6		-	-	-
11	El-Barkah	CPP/PHE 54			71.233,6				-	-	-
<b>Total A</b>			<b>95.903,84</b>	<b>1.626.287,39</b>	<b>455.741,89</b>	<b>4.571.769,50</b>	<b>476.443,40</b>	<b>4.615.533,47</b>	<b>10.813.590,36</b>	<b>249.328,59</b>	
<b>B Supporting Facilities related with Production Process</b>											
12	E-Forklift	Lamongan Shorebased	365,4	5.275	366,5	5.973	380,7	8.681	19.929	17.328,88	2,90
13	LEGL – Less Energy Green Lamp	PPP, ORF, CPP/PHE-5	708,2	15.443	722,5	15.586	722,5	15.779	46.809	9.435,58	0,61
14	Hybrid Energy using photovoltaic system	PPP, ORF, CPP/PHE-5	314,2	6.833	314,2	6.797	314,2	6.863	20.513	5.072,57	0,75
15	Be Cool With New Refrigerant	PPP, ORF, CPP/PHE-5	3.488,7	76.081	3.518,4	75.902	3.518,4	76.842	228.825	7.971,91	0,11
16	TFS – Taxi to Shuttle Boat management System	FSO Abharka	91.577,0	1.321.993	139.259,4	2.269.179	133.255,6	3.038.383	6.629.555	-	-
17	Crabs	PHE-30			182,4		304,0		-	36.978,88	12,44
18	Recreation – Rescheduling Crew Change Action	FSO Abharka			8.122,5		10.340,0		-	-	-
<b>Total B</b>			<b>96.453,48</b>	<b>1.425.645,80</b>	<b>152.486,00</b>	<b>2.373.436,71</b>	<b>148.835,51</b>	<b>3.146.548,02</b>	<b>6.945.630,53</b>	<b>76.787,81</b>	
<b>Total A+B</b>			<b>192.357,3</b>	<b>3.051.933</b>	<b>608.227,9</b>	<b>6.945.206</b>	<b>625.278,9</b>	<b>7.762.081</b>	<b>17.759.221</b>	<b>326.116</b>	

Figure 10 Energy management action plan

Energy management action plan is determined on yearly-basis based on strategic plan. In addition to energy efficiency program identified from energy audit, PHE WMO also harness improvement working culture from its employee to identify opportunity for energy saving. Pertamina’s “Continuous Improvement Program” (CIP) is a catalyst for the innovation and ideas for energy efficiency as part of continuous improvement.

**“Energy is core of the life, let us activate body and soul to sustain energy transformation.”**

— Supto A. Sudarmanto – PHE WMO Field Operation Manager

### Capacity Building

To implement EnMS ISO 50001, PHE WMO provided competent personnel including energy manager, national certified energy auditor, EnMS ISO 50001 internal audit. Currently PHE WMO has a nationally certified energy manager, four nationally certified energy auditors and 69 ISO 50001:2018 internal auditors. For technical competency, PHE WMO has conducted training for SEU personnel both operation and maintenance team.

### Monitoring Measurement Plan

Energy team and operations team determined monitoring and measurement schedule to ensure improvement of energy performance of each SEU. PHE WMO developed applications developed BABLEFISH server, CCMSYS, and El-Barkah. BABLEFISH server is used for data collection for energy data, production data, and other relevant data and connected them to a local network and monitored in real time basis. Computerized Centered Maintenance Management System (CCMSYS) is a predictive maintenance application developed based on energy criteria. CCMYS contains database of equipment specifications and configurations, asset health information, a list of findings based on energy criteria, performance achievements and maintenance backlogs as well as a Pareto graph of SEU’s maintenance.



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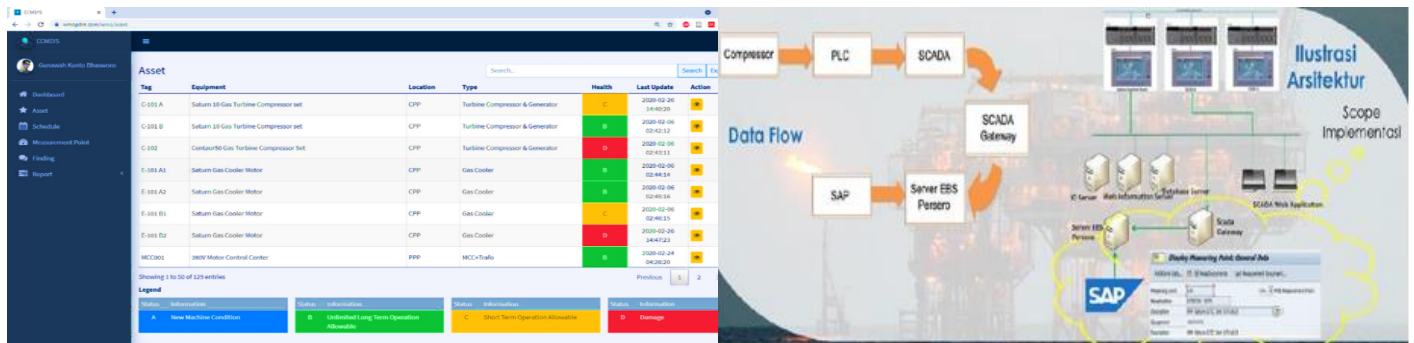


Figure 12 CCMSYS application & El-Barkah Operating Principle

El-Barkah (Electronic Basis Redundancy Control via HMI) functions as an integrated control and monitoring function of SEU 3 Gas Turbine Compressor (GTC) units to facilitate real-time supervision from control Room. El-Barkah has reduced downtime by 99.1% from 3 GTC units. Tracking achievement of energy efficiency targets, PHE WMO measured operational data, analyzed, and compared with the baseline as shown in Figure 12. The baseline calculation based on variable (x1) oil production and (x2) gas production, and baseload. Energy baseline equation is  $y = 0.94 \cdot X1 + 0.99 \cdot X2 + 13,508$ .

EnPI equation (2020)  
 $y = 0.94 \cdot x1 + 0.99 \cdot x2 + 13508$

Bulan	Produksi (sales)					Intensitas	En Cons Predicted	Energy Consumption Actual					Energy Difference			
	Minyak (Bbls)	Gas (mmscf)	Minyak (TOE)	Gas (TOE)	Total (TOE)			Produced water	GJ/TOE	GJ	Gas (GJ)	Diesel (GJ)	Listrik (GJ)	Total, GJ	GJ	Cusum (GJ)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Sep	167.145	2.720	22.000	63458	85458	1152173	1.44	164.334	115.766	7.090	224	123.080	(41.253)	(41.253)		
Oct	161.268	2.780	22.577	64875	87452	1209091	1.38	168.280	115.697	4.773	236	120.707	(47.573)	(88.826)		
Nov	165.015	2.560	21.702	59730	81432	1154929	1.45	162.167	111.700	6.040	253	117.993	(44.174)	(133.001)		
Dec	160.099	2.493	22.414	58174	80588	1105269	1.62	166.893	121.830	8.313	233	130.375	(36.518)	(169.519)		
Jan'21	165.181	2.315	21.725	54018	75743	1132647	1.75	162.081	125.725	6.690	224	132.638	(29.443)	(198.961)		
Feb	133.159	1.972	18.642	46017	64659	1051171	1.79	140.982	111.127	4.117	206	115.449	(25.533)	(224.494)		
Mar	148.213	2.087	20.750	48690	69440	1193155	1.94	155.286	127.657	6.809	187	134.652	(20.634)	(245.128)		
Apr	139.850	2.033	19.579	47430	67009	1130761	2.00	147.350	126.246	7.261	212	133.719	(13.631)	(258.759)		
May	141.388	2.051	19.794	47847	67642	960765	1.98	148.817	128.795	5.065	211	134.071	(14.746)	(273.505)		
Jun	136.127	1.837	19.058	42856	61914	1098806	2.09	143.646	123.651	5.302	238	129.191	(14.455)	(287.960)		
Jul	136.822	1.790	19.155	41767	60922	1039939	2.15	144.254	125.802	5.254	227	131.283	(12.971)	(300.931)		
Aug	135.616	1.751	18.986	40854	59840	1048699	2.13	143.079	122.851	4.594	219	127.664	(15.415)	(316.346)		
Sep	121.023	1.531	16.943	35715	52659	1147112	2.52	129.105	127.975	4.714	224	132.913	3.809	(312.537)		
Oct	123.158	1.629	17.242	38003	55245	1106585	2.55	131.215	135.693	5.028	236	140.957	9.743	(302.795)		
Nov	116.891	1.568	16.365	36594	52958	1063113	2.54	125.247	129.877	4.192	253	134.322	9.075	(293.720)		
Dec	119.796	1.524	16.771	35660	52331	1026349	2.41	127.942	120.216	5.499	233	125.948	(1.993)	(295.713)		
Jan'22	128.133	1.291	17.939	30125	48063	942647	2.91	135.569	135.662	4.221	213	140.097	4.528	(291.185)		
Feb	112.733	1.280	15.783	29862	45645	895214	2.80	121.042	124.036	3.758	207	128.001	6.959	(284.225)		
Mar	130.189	1.413	18.227	32963	51189	1003954	2.80	137.628	138.838	4.493	208	143.539	5.911	(278.315)		
Apr	129.276	1.455	18.099	33952	52050	1020839	2.66	136.809	132.413	5.823	214	138.450	1.641	(276.673)		

Figure 13 Baseline equation

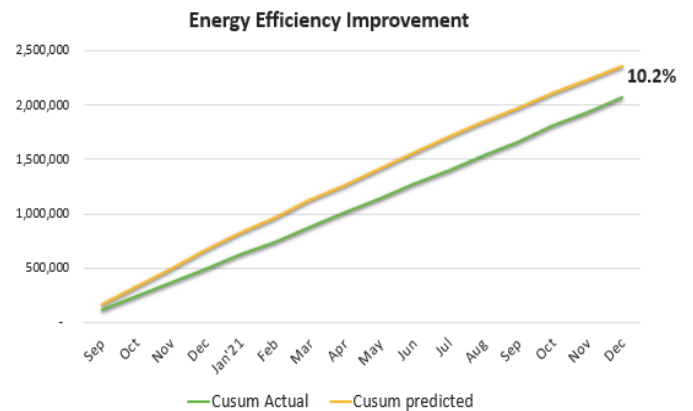


Figure 11 Cumulative energy efficiency improvement

The calculation results compared to baseline indicates that PHE WMO achieved energy efficiency of 10.2%. The achievement surpassed the target of 5% in 2025 or 0.08% annually. The efficiency results are reported to top management on a monthly basis as well as to internal and external interested parties on a monthly, quarterly and annual basis. Although energy intensity is not a measure to track its energy performance, PHE WMO still monitor its energy intensity as environmental performance benchmark within Pertamina Group and Indonesia's Petroleum Association (IPA).

## Verification and validation

Energy performance measurement and monitoring of SEU is carried out by operators who are competent and checked by energy auditors and approved by energy managers. The results of EnMS implementation as well as energy saving are reported to Pertamina Persero as parent company and to the Ministry of Energy and Mineral Resources, Government of Indonesia.

## Internal audit and management review

Internal audit of EnMS ISO 50001 conducted annually and is chaired by nationally certified energy auditor. Internal audit activities and its audit report are reported to top management during management review. Top Management demonstrates its support to EnMS implementation by providing sufficient infrastructure and budget to improve EnMS and achieve EnMS target such as budget for personnel competence, innovation program as well as renewable energy. Top Management shows his appreciations to employees and contractors who are involved in EnMS program during management walkthrough, management review and employee performances review.

## Transparency

PHE WMO obtained its certification of EnMS ISO 50001:2018 implementation in 2020. PHE WMO promoted and publicized its achievement to both internal and external parties.

## Internal Organization

PHE WMO communicated internally using several publications means such as banners, stickers, broadcasts and direct communication in every morning meeting.

## External Organization

### 1. Energy Contest

- Continues Improvement Program organized by Pertamina where PHE WMO is consistently participating with energy related innovation proposal
- The winner National Energy Award organized ministry of EMR for large scale industries in mining and energy sector
- ASEAN Energy Award organized by ASEAN Center for Energy where PHE WMO participated representing Indonesia

### 2. Government Assessment

- To Ministry of Environment and Forestry Government of Indonesia as in PROPER Rating/Assessment
- To Ministry of Energy and Mineral Resources Government of Indonesia via Online Energy Management Reporting System annually since 2019
- Sustainability report published annually and available for any stakeholders

### 3. PHE WMO's Patent

- Innovation SAJANE granted Copyright Patent No. EC00202036906. Winner of Gold Medal in CIP Forum PHE.
- Innovation Turbo CTAR granted Copyright Patent No. EC00201928821. Winner of Platinum Medal in UIIA Forum dan APQA 2018 in Jakarta.
- Innovation El Barkah granted Copyright Patent No. 000115110. Winner of Platinum Medal in UIIA Forum dan APQA 2018 in Jakarta and 3 Stars Awards & Best Presentation in CIP Forum APQO.
- Innovation X-Treme granted Copyright Patent No. EC00202156558. Winner of Platinum Medal in UIIA Forum.

## What We Can Do Differently

- Provide monitoring and measurement tools on equipment that the data result is more accurate
- Identification of long-term energy efficiency program to continually improve energy performance and ensure sustainability of PHE WMO's energy management system
- Provide more competent personnel in each area to raise knowledge of energy management
- Innovative approach of EnMS communication
- Attractive reward mechanism for energy role model.



Figure 14 PHE WMO ISO 50001:2018 certificate