

A woman with curly hair, wearing a light blue t-shirt, is shown in profile, looking down at a package of fresh produce in a grocery store aisle. The shelves are stocked with various items, including bags of vegetables and a display of pens. The background is softly blurred, emphasizing the woman and the products she is examining.

An ExxonMobil view of future trends in the PE flexible packaging industry

Energy lives here™

ExxonMobil

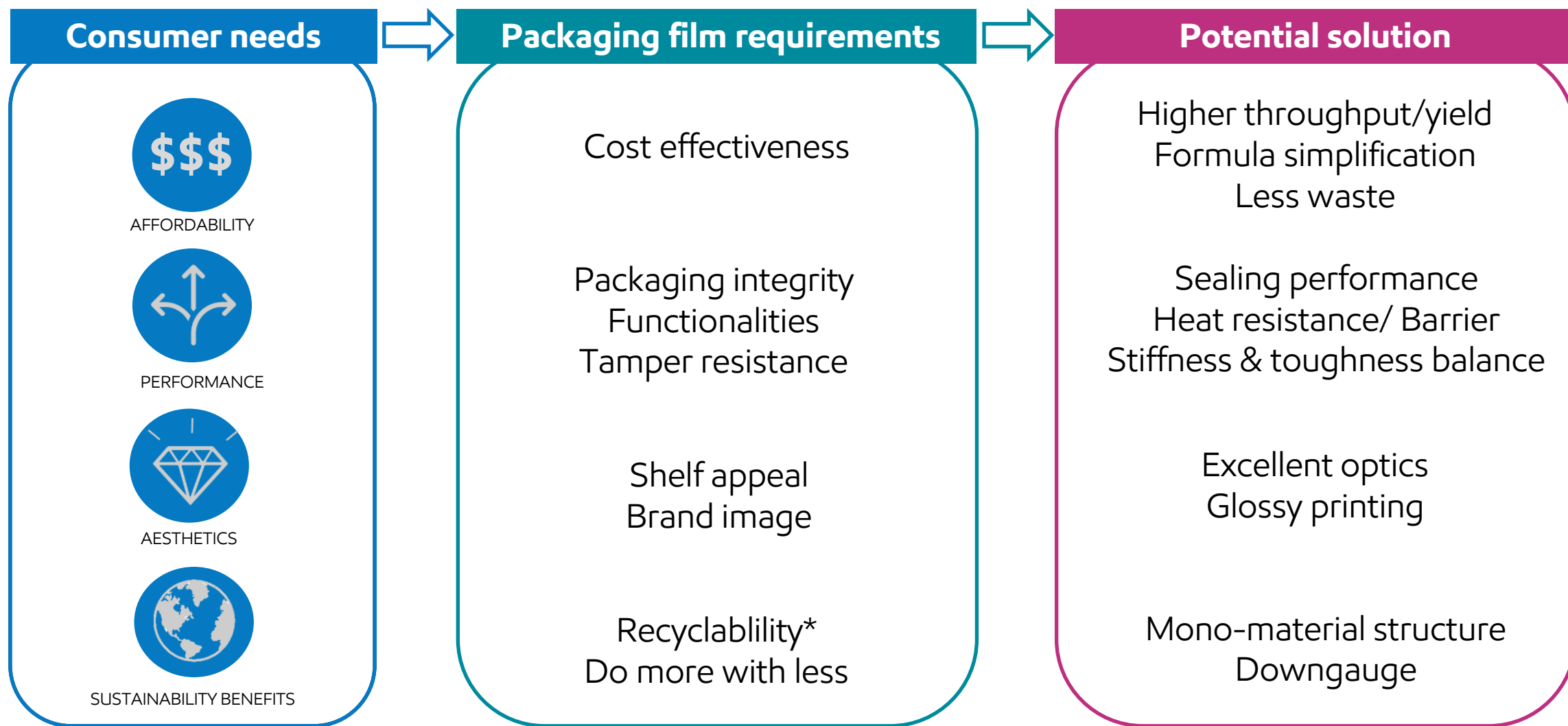
Packaging market is evolving with consumer trends



*Recyclable in communities with programs and facilities in place that collect and recycle plastic film

Source: Euromonitor 2021; ExxonMobil estimate based on Value Chain interaction

Flexible packaging market trends and drivers



*Recyclable in communities with programs and facilities in place that collect and recycle plastic film.

ExxonMobil's approach to flexible packaging

Differentiate with ExxonMobil performance polymers:

Exceed™ S

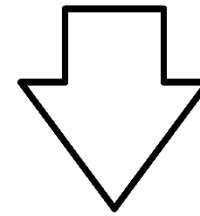
Exceed™

Exact™

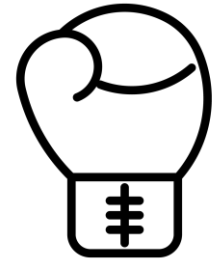
Enable™

Exceed™ XP

ExxonMobil



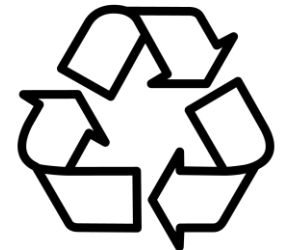
Do more with less
Simplify formulation



Enhance mechanical
performance



Improve sealing
performance



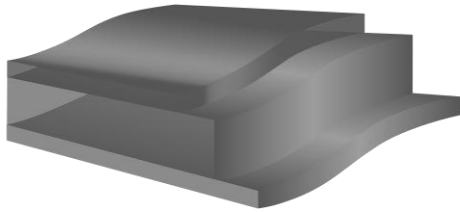
Full PE formulation can
improve film
recyclability* potential

*Recyclable in communities with programs and facilities in place that collect and recycle plastic film.

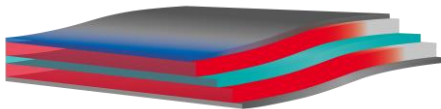
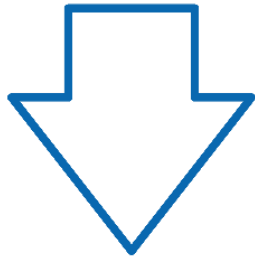
A photograph of a workshop floor. In the foreground, a clear plastic bag lies on a dark, reflective surface. In the background, a metal structure with bolts and nuts is visible. The text "Do More with Less" is overlaid in white.

Do More with Less

Do More with Less



thickness reduction
2-3%/yr across film
applications '10-'21

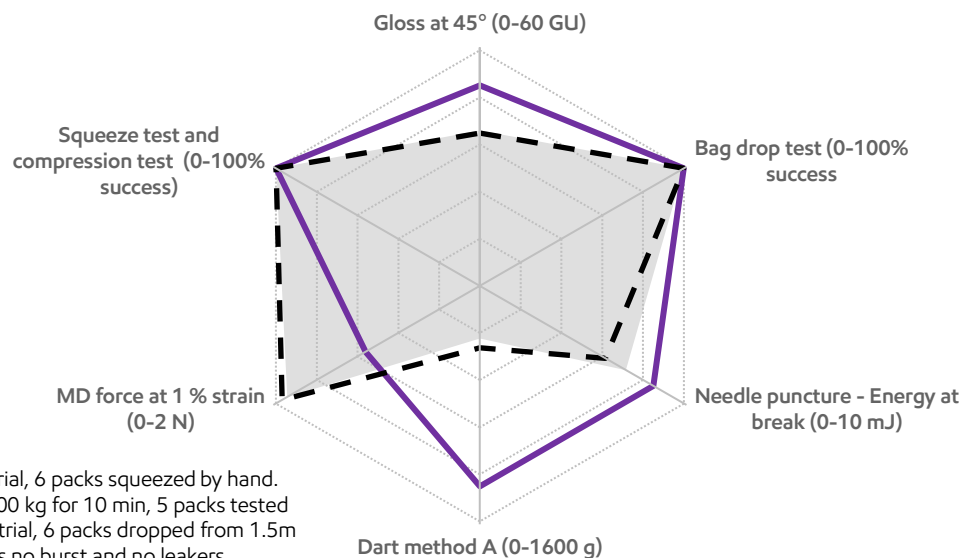


- ExxonMobil estimates that in 2021 film downgauging, achieved with the use of our Performance Polyethylene, helped to enable the film value chain to **avoid ~1.3 MT** of plastic consumption vs. 2010 reference¹



¹ ExxonMobil analysis, aggregated numbers across 30 film segments and sub-segments

Downgauging opportunity



Exceed™ and Exceed™ XP performance polymers based solutions provide:

- Downgauging (DG) opportunity up to 19%
- Excellent seal and hottack performance
- Maintain bag-drop performance despite DG

Reference 1
61 µm

Reference 2
64 µm

**Exceed XP 6056 +
Exceed XP 8784**
52 µm

Ratio

1/2/1

Outer

80% C8-mLLDPE
20% LDPE

80% C8-mLLDPE
20% LDPE

60% Exceed 1012
40% Exceed XP 6056

Core

51% C8-mLLDPE
30% C4-LLDPE
11% LDPE
8% white MB

51% C8-mLLDPE
30% C4-LLDPE
11% LDPE
8% white MB

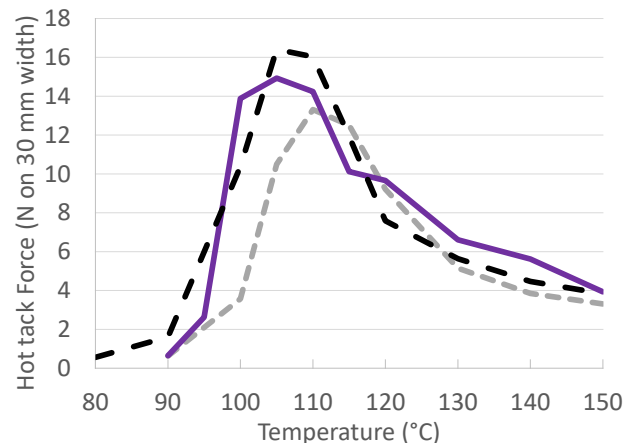
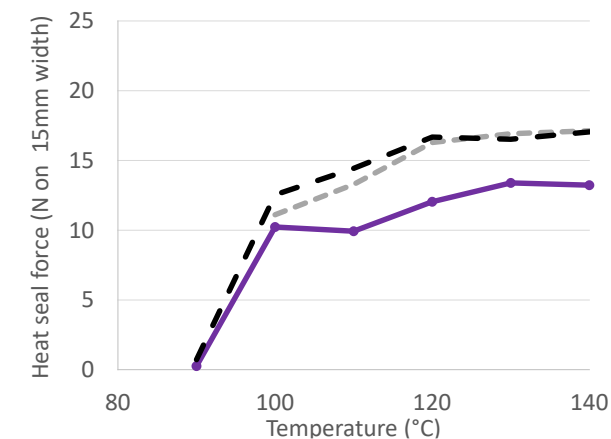
92% Exceed XP 8784
8% white MB

Sealing

80% C8-mLLDPE
20% LDPE

55% C8-mLLDPE
25% C8 plastomer
20% LDPE

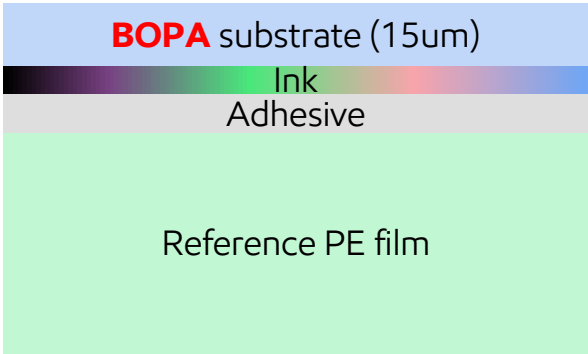
60% Exceed 1012
40% Exceed XP 6056



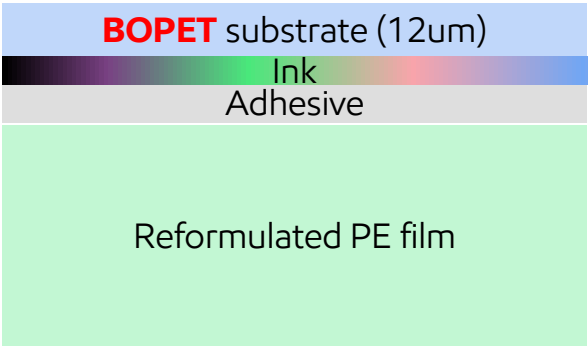
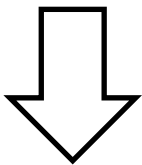
ExxonMobil

PA Replacement

Outside



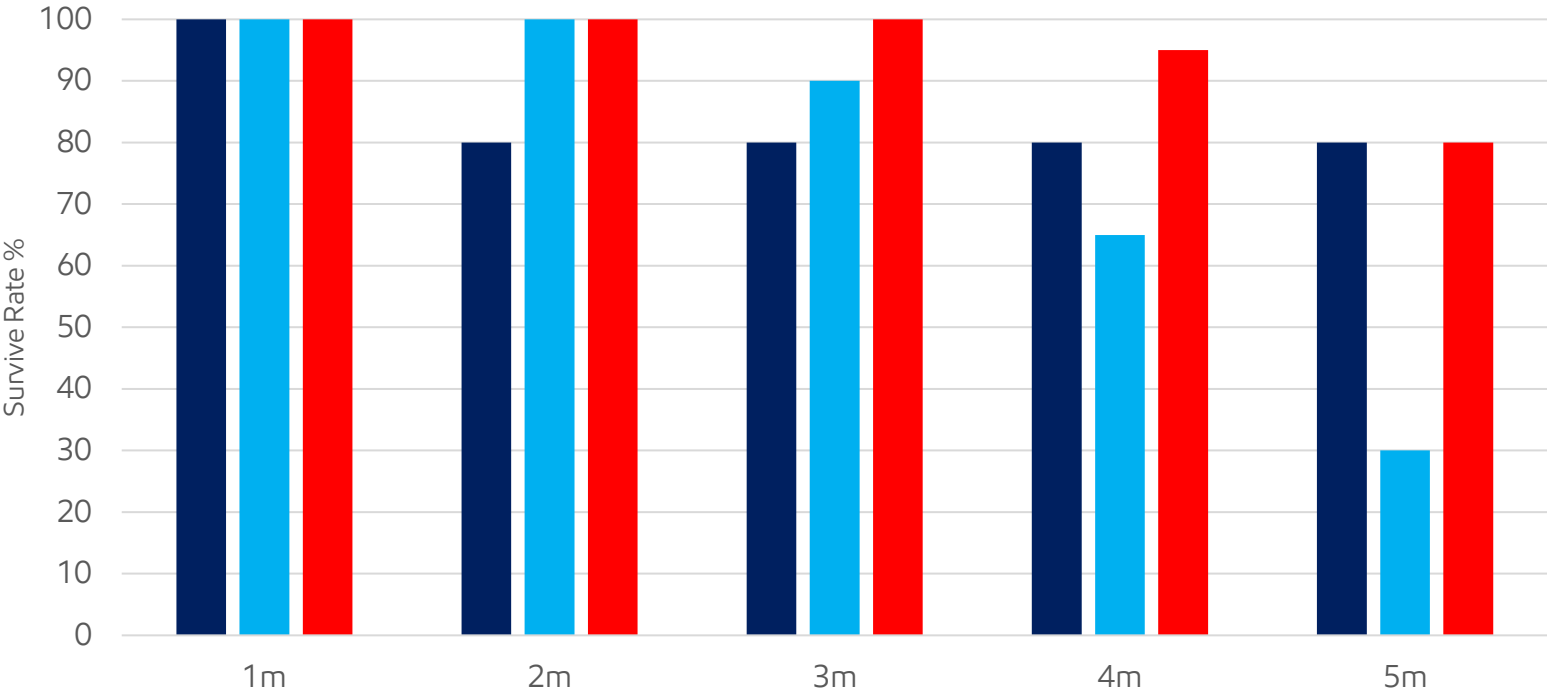
Sealing Side



Up to **15%** cost savings potential per unit



Bag Drop Performance



■ BOPA/Reference PE

■ BOPET/Reference PE

■ BOPET/EM PE



Reference

80 µm PE

EM

80 µm PE

Formulation

C8 LLDPE/HDPE/LD

Exceed™XP/Exceed™/HD

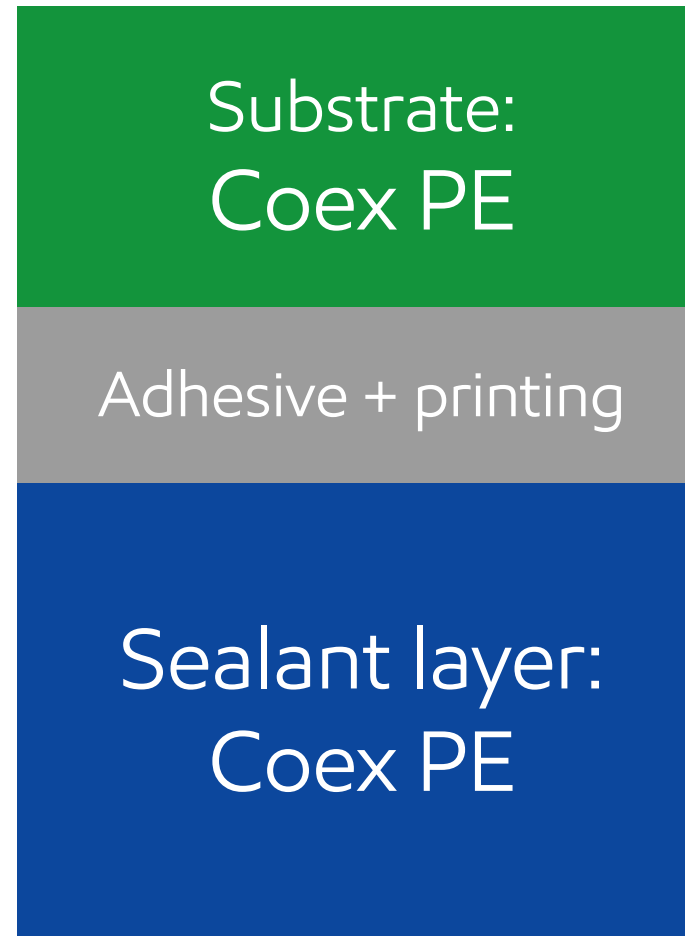
C8 LLDPE (0.920d, 1MI), Exceed™ XP 8656 (0.916d, 0.5MI),
Exceed™ 1012 (0.912d, 1MI), HD (0.961d, 0.7MI), LD (0.923d, 0.75MI)

Note: Calculation here are indicative only
Bag drop performed on 2.5kg SKU
Tests performed by or on behalf of ExxonMobil

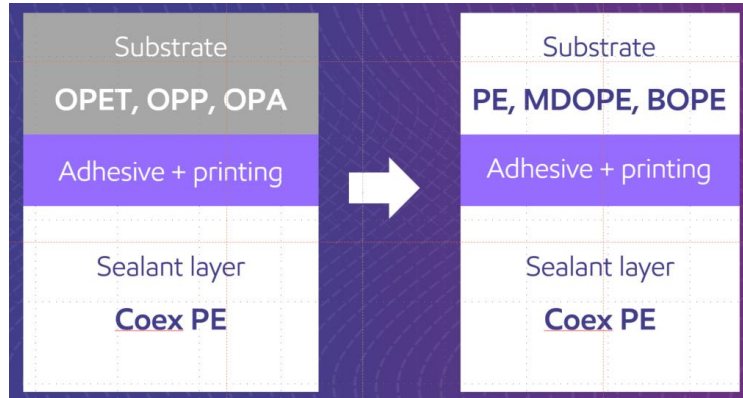
A woman with long dark hair is smiling and looking down at a baby in a carrier. She is holding a large, clear, full PE laminated shopping bag. The background is a blurred store interior with various items on shelves. The text "Full PE laminated solution" is overlaid in white on a dark grey semi-transparent background.

Full PE laminated solution

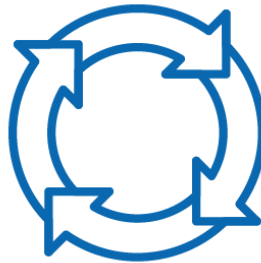
Full PE laminated solution for multi-material laminate replacement



Design for recyclability*

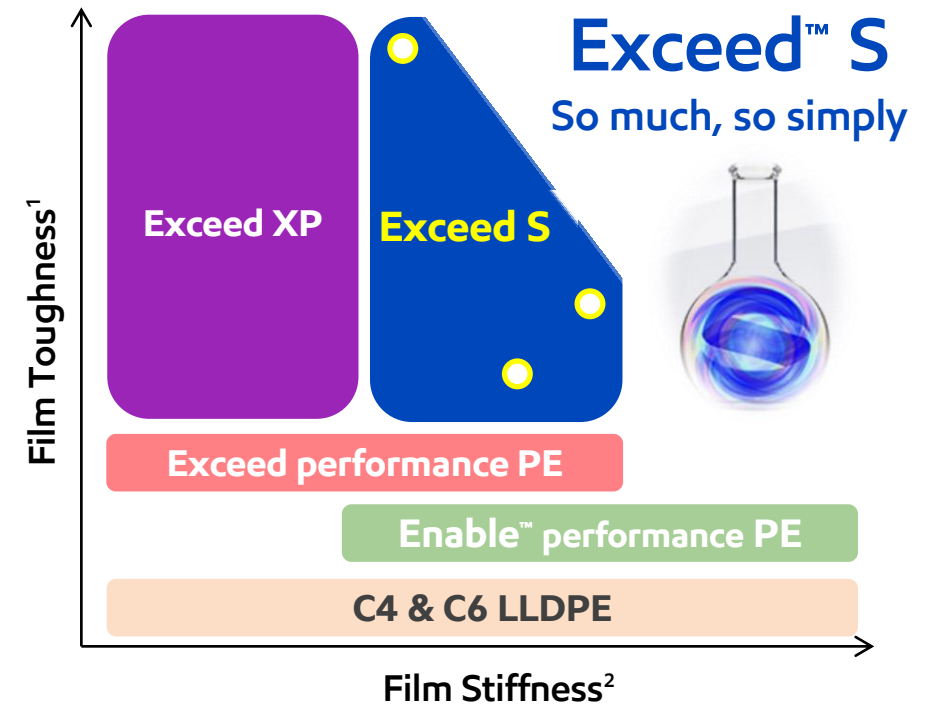


Pillow packs & medium duty bags
Consumer & commercial goods



Recyclable*, tough all-PE laminates with Exceed™ XP and Exceed™ S performance PE

Pinch bottom pouch
Dry & liquids goods



1. Toughness measured by dart drop impact, 0 – 29.5 g/μm
2. Stiffness measured by 1% Secant Modulus (MD), 180 – 380 Mpa

PE//PE structures

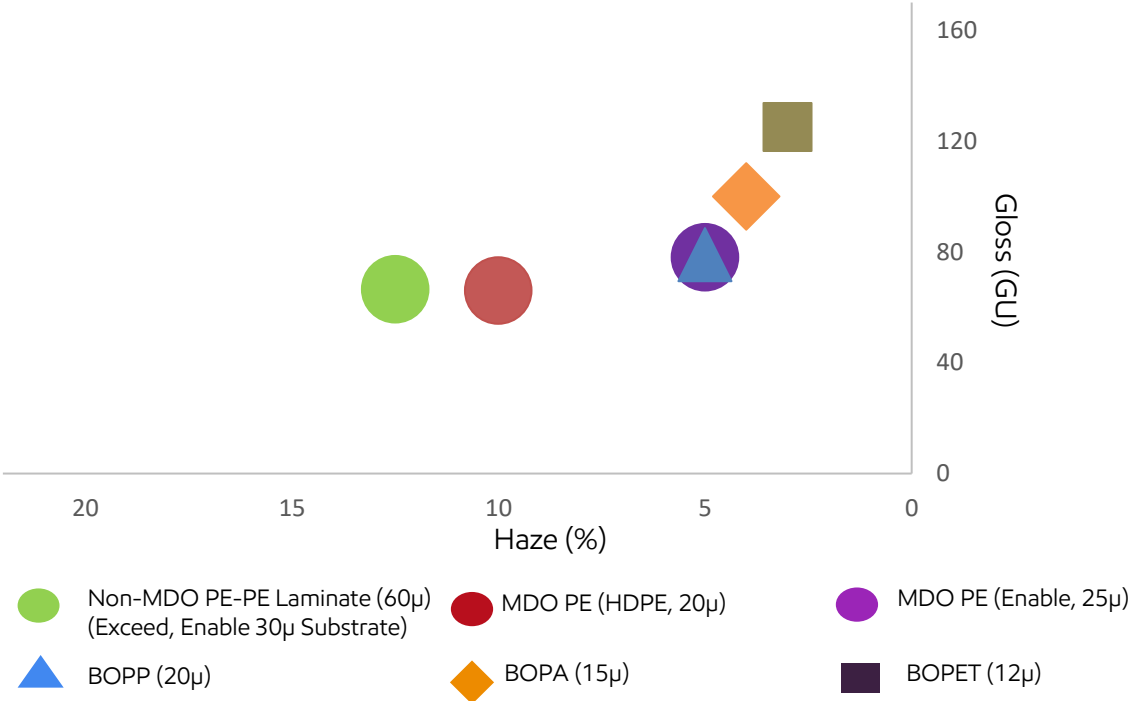
Exceed™ S, Exceed™ XP, Exceed™ and Enable™ performance polymers and Exact™ plastomers

	Key requirements	ExxonMobil solutions	Grades
Substrate film	Modulus Flatness Optics Heat resistance	MDO solutions Non-MDO solutions	Exceed S Exceed XP Enable Exceed HTA 108
Sealant film	Toughness Low SIT Seal strength COF control	3-layer/5-layer solutions	Exceed S Exceed XP Exceed Exact

Substrates for Flexible Packaging

Film Attributes Comparison*

Attributes	Non-MDO PE	MDO PE
Stiffness	-	++
Toughness	+	-
MD Tear	+	-
Heat Resistance	+	+
Cost Competitive**	++	+
Printing	-	++
Bag Making Process	-	+



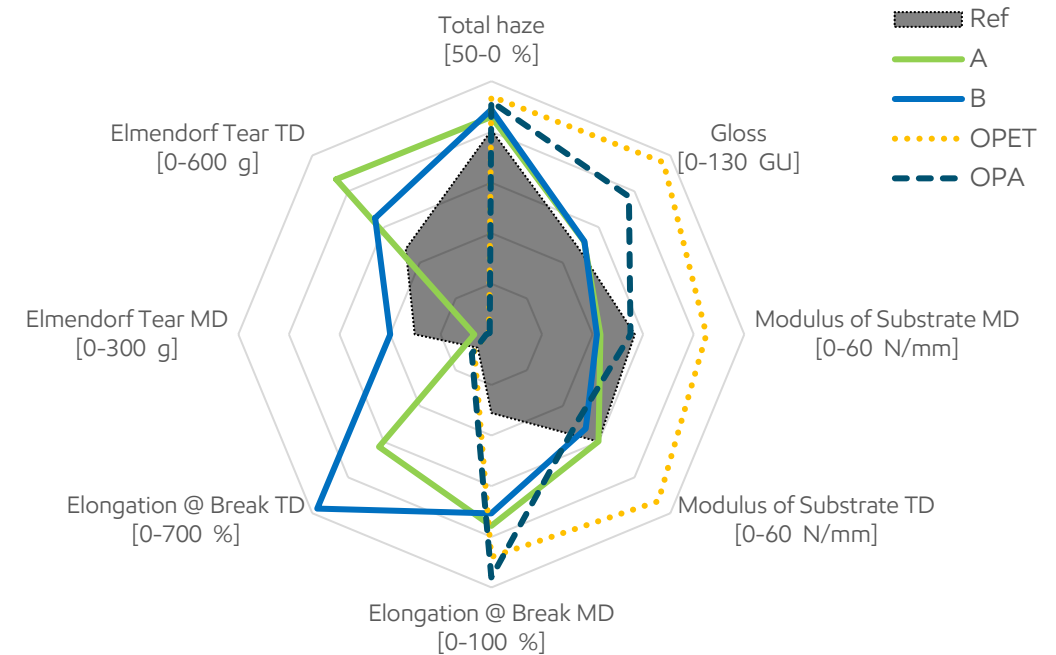
**EM Estimate & Common Industry Practice as of date*
***MDO PE will require an additional capability investment*

*MDO PE (Enable) with Enable™ 4002 performance PE in the skin (MDO ratio 4.8) and MDO PE (HDPE) with HDPE in the skin (MDO ratio 6); HDPE (0.961g/cm³, 0.7g/10min)
 **Non-MDO PE-PE Laminate with Exceed™ 1327performance PE in the skins and Enable™ 4002 performance PE in the core
 **All data from tests performed by or on behalf of ExxonMobil

MDO PE Substrates with ExxonMobil performance PE

MDO PE substrate solution using **Enable™** & **Exceed™ S** performance polymers

- **Easy Processing**
 - Excellent bubble stability
 - Easy stretch ability and separation of flattened bubble
- **Excellent optics**
 - Similar haze/gloss properties to BOPP/BOPA
 - As low as ~5%
- **Great Mechanical Properties**
 - Film properties consistency assurance
 - Balance between MD and TD Elmendorf tear
 - Great MD modulus for both flexo and rotogravure printability



Ref is MDO PE based substrate using mC8LLDPE

A is MDO PE based substrate using **Enable™** performance PE

B is MDO PE based substrate using **Exceed™ S** performance PE

Non-MDO PE Substrates with ExxonMobil performance PE

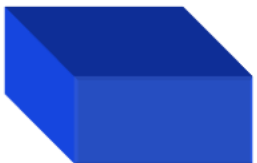
Converters without MDO machines can go ahead with Non-MDO PE substrates for PE//PE Laminate solutions

For any Substrate Film, the key requirements are:

- Stiffness (During Printing)
- High Gloss (Overall aesthetics & printing)
- Heat Resistance (FFS performance)
- Gauge Control

As there is no downstream operation on the film (unlike MDO) – The stiffness & optics of the film is achieved with EM pPE & right formulation balance

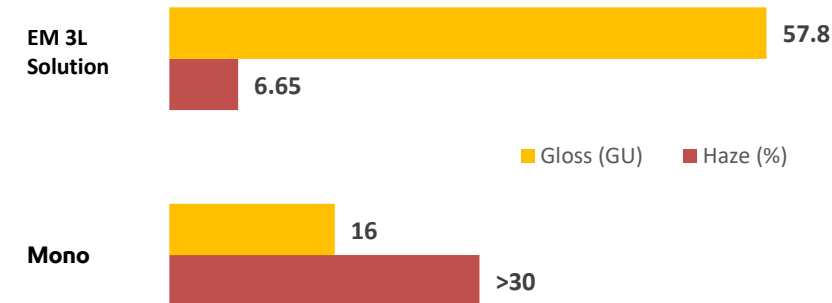
Monolayer film of Exceed™ 1327 performance polymer
25 µm



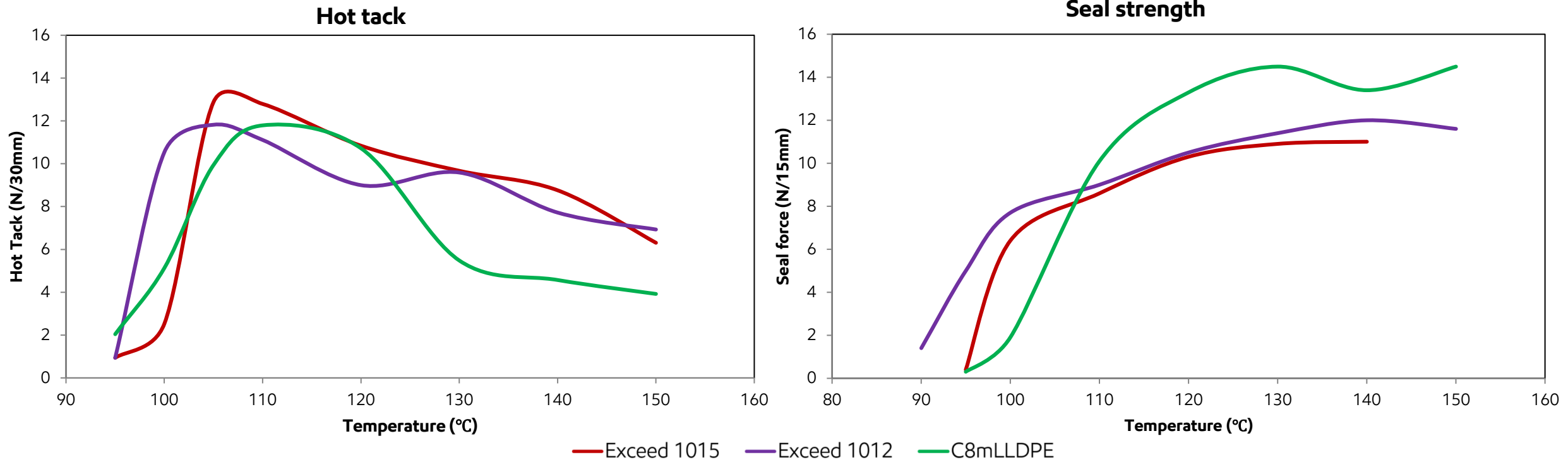
ExxonMobil 3Layer Solution (Enable™ & Exceed™ performance polymers)
30 µm (1/3/1)



- A: Exceed 1327 + HTA 108 [80:20]
- B: HTA108 + Enable 4009 [80:20]
- C: Exceed 1327 + HTA 108 [80:20]



Ease of sealing with Exceed™ performance PE



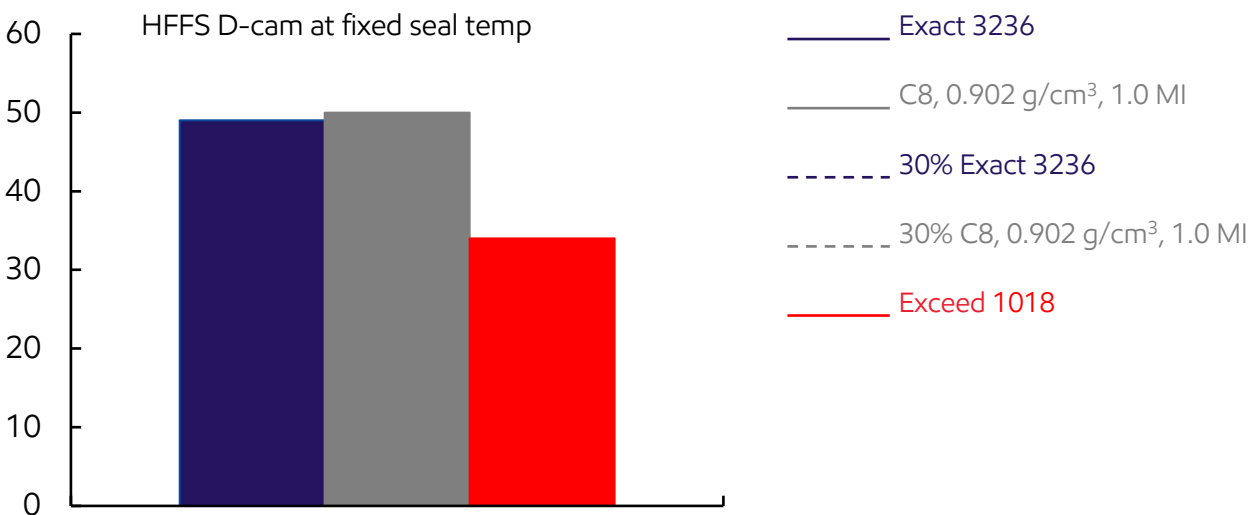
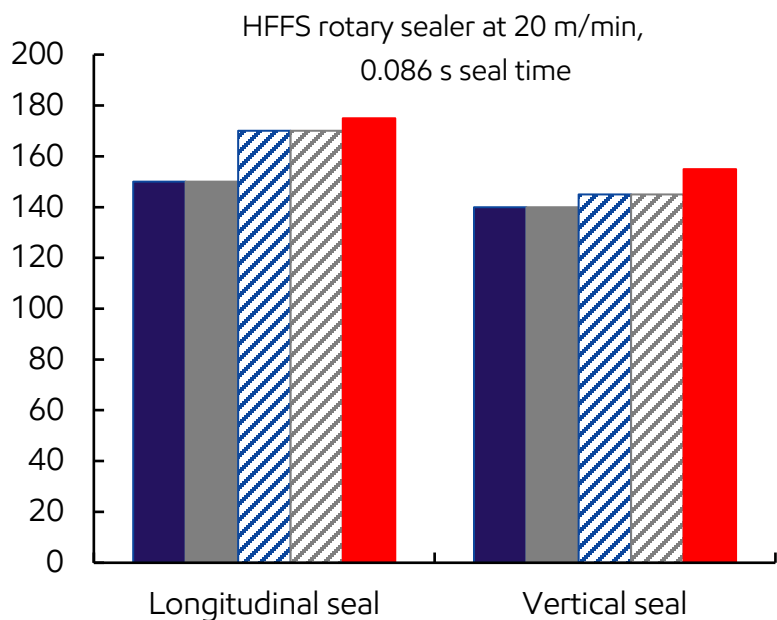
- **Enhanced sealability comparing to C8 mLLDPE leads to improved package integrity**
 - Broad hot-tack window similar with C8 mLLDPE
 - Excellent SIT with potential ~5°C lower than leading C8 mLLDPE

Ref: Exceed 1015 (1MI;0.915 d); Exceed 1012 (1MI;0.912 d); C8 mLLDPE (1 MI; 0.916 d)

Improve sealing speed with ExxonMobil Exact™ Plastomers

Seal temp (°C) needed at fixed line speed to obtain hermetic packs

Max line speed (m/min) at fixed seal temperature to obtain hermetic packs



Exact™ 3236 performed fluently on HFSS lines during packaging trial

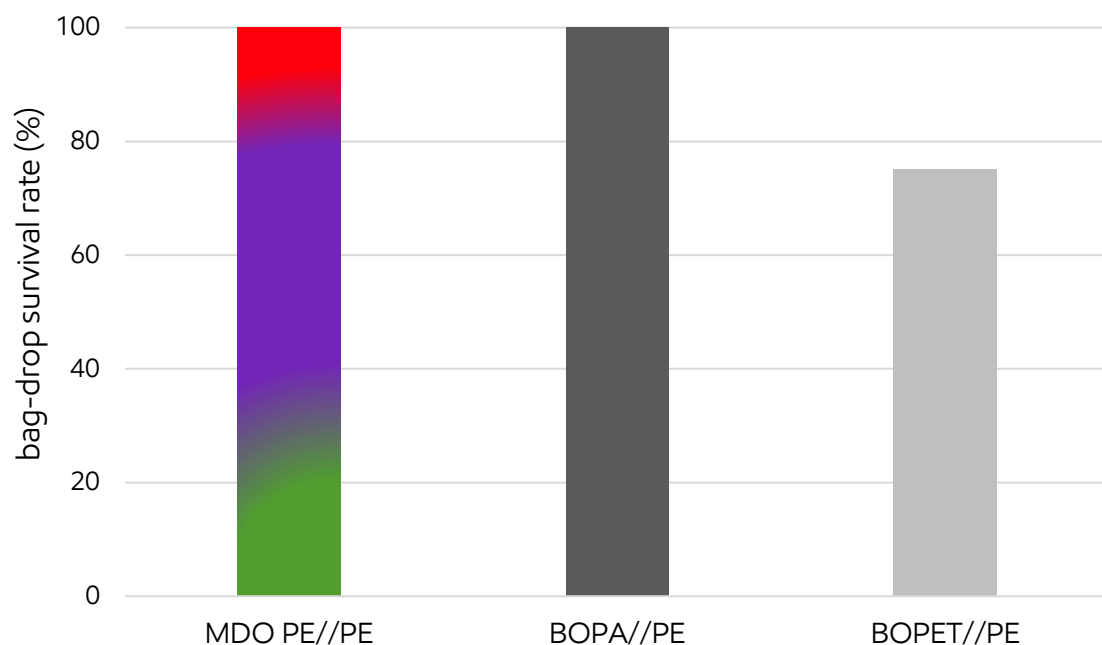
	Plastomer coex structure, 50µm, 1/2/1
Inner skin	75% Exceed™ 1018 + 25% Enable™ 2005
Core	83% Enable™ 2005 + 17% HDPE (0.961g/cm³, 0.7 g/10min)
Sealant skin	100% or 30% plastomer with remainder Exceed™ 1018



Exact™ plastomer resins. Data from tests performed by or on behalf of ExxonMobil. Packaging line data (seal temp. and max line speed) are generated by ExxonMobil at third party, and should only be used as comparative data

Packaging integrity in full PE solution

SUP bag-drop survival rate (1.5 m)



ExxonMobil 5L MDO PE// PE solution using **Exceed™** **XP**, **Exceed™**, **Enable™** performance polymers can provide:

- Excellent bag drop performance
- Fulfilled end use requirements
- Full PE structure for improved recyclability potential*

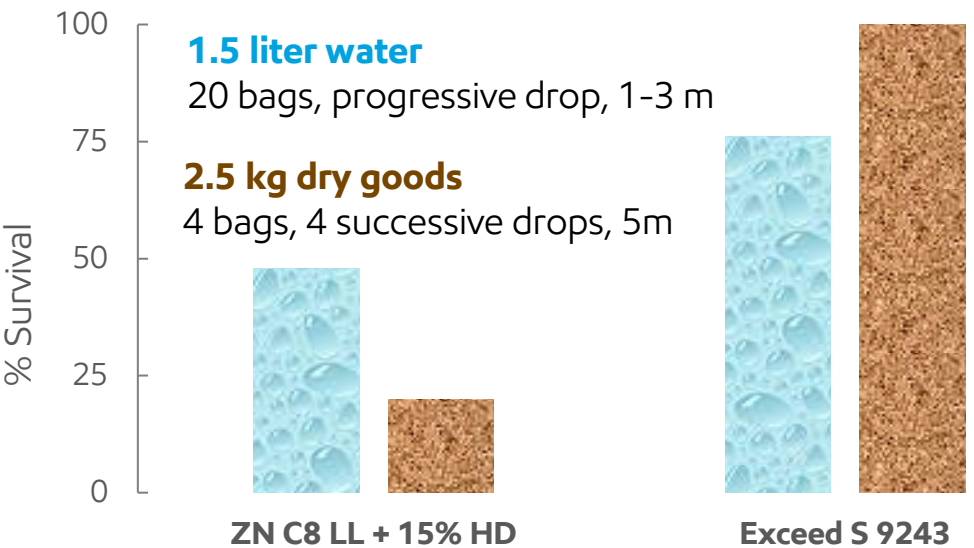
Substrate	Sealant
25 µm	120 µm
MDO PE (EM Solution)	Exceed XP 8784, Exceed™ 1012 HDPE
BOPA (15 µm)	Market ref
BOPET (12 µm)	

* Recyclable in communities with programs and facilities in place that collect and recycle plastic film

Enhanced package integrity with Exceed™ S performance PE

BAG DROP – Laminated VFFS BAGS

- Failure on the wall of the bags



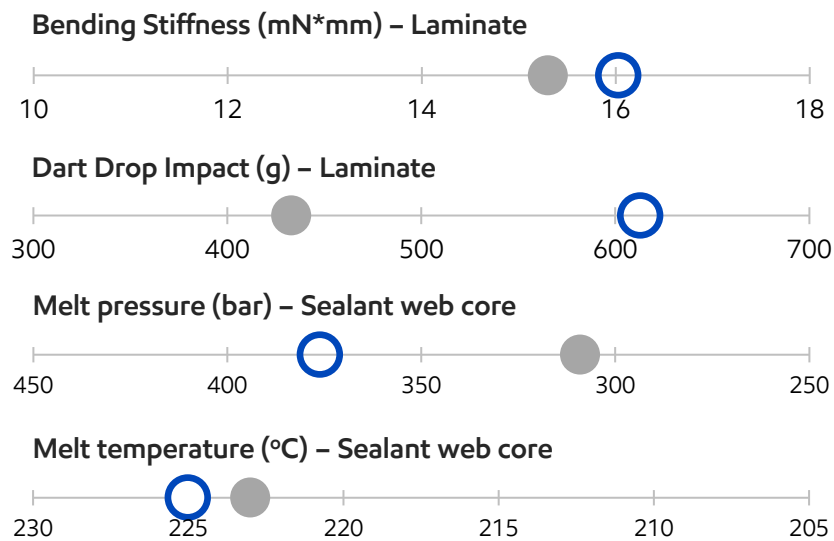
	Reference	Exceed S 9243
	60 µm 1/3/1	
Sealant skin ¹	mLL C8 (1.0; 0.916) + 10% LD150	Exceed 1012 + 10% LD150
Core ²	ZN C8 (1.0; 0.920) + 15% HDPE ³	Exceed S 9243
Skin ¹	Exceed 1018	
Adhesive		
Substrate	25 µm MDO PE	

Exceed™ S performance polyethylene enhances package toughness

- Exceed S 9243 improves dart and bag drop performance

Exceptional stiffness enables simplification & optimization

- Eliminates the need to 15% HDPE to the core
- Enables change to 0.912d sealant skin to improve sealing



A woman with dark hair, wearing a blue and white striped shirt, is looking down at a bag of chips she is holding. She is holding a single chip up to her finger. The background is softly blurred, showing what appears to be a kitchen or dining area with a window and some plants.

Approach to create recyclable* high barrier PE films

* The terms "recyclable" and "recyclability" as used throughout this presentation are intended to refer to the potential for recyclability of full PE solutions designed and manufactured in accordance with recycling guidelines such as PRE RecyClass. Ultimate recyclability of full PE packaging incorporating ExxonMobil's performance PE resins will depend on a number of factors outside of ExxonMobil's control including, but not limited to, availability of programs and facilities that collect and recycle plastic packaging within a given community. Any and all claims about the recyclability of full PE-packaging are the sole responsibility of the packaging manufacturer

ExxonMobil

There are various approaches to barrier in recyclable* PE-based packaging

Barrier on printing web (MDO-PE or cast PE)



MDO-PE with PVOH coating



Cast PE with nanoclay coating

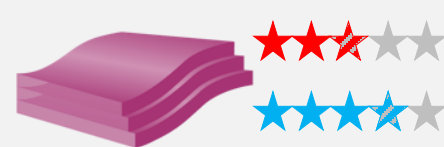


MDO-PE with EVOH

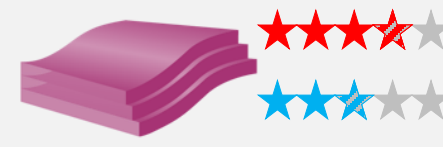


MDO-PE with AlOx & top coating

Barrier on sealant web



PE metallized



PE/EVOH

N.B. All barrier values are to be considered as indicative. Customers need to evaluate themselves which levels of barrier they can achieve.

Barrier scale	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
OTR (23°C; 0% r.h.) [cm ³ /m ² /d]	>100	10 – 100	1 – 10	0.1 – 1	<0.1
WVTR (37.8°C; 90% r.h.) [g/m ² /d]	>10	3 – 10	0.5 – 3	0.1 – 0.5	<0.1

K Show Collaboration Showcase

Exceed™ XP Exact™ Enable™ Exceed™ S
Case Study

ExxonMobil



Creating a circular film to film loop:
from a recyclable* full PE barrier packaging
solution to a high end heavy duty sack



Recyclable* and
incorporates
recycled content



Outstanding
oxygen
barrier



Tremendous
optics



High package
integrity



**HOSOKAWA
ALPINE**



Selene

Exceed™ XP Exact™ Enable™ Exceed™ S
Case Study

ExxonMobil



Recyclable* 97% PE barrier pouch packaging
with high oxygen barrier, unique optics and
outstanding package integrity



Recyclable



Outstanding
oxygen
barrier



Tremendous
optics



Outstanding
package
integrity



**HOSOKAWA
ALPINE**



KARLVILLE
BEYOND CONVERTING



ExxonMobil

* Recyclable in communities with programs and facilities in place that collect and recycle plastic film

K Show Collaboration Showcase

Exceed™ XP Exact™ Exceed™ S
Case Study

ExxonMobil



Recyclable PE pouch packaging solution
with ethylene vinyl alcohol for excellent
barrier performance



By collaborating with the value chain, ExxonMobil is helping customers create
recyclable* packaging solutions.

 Recyclable*

 Package
integrity
maintained

 Barrier
performance

 Optical
properties

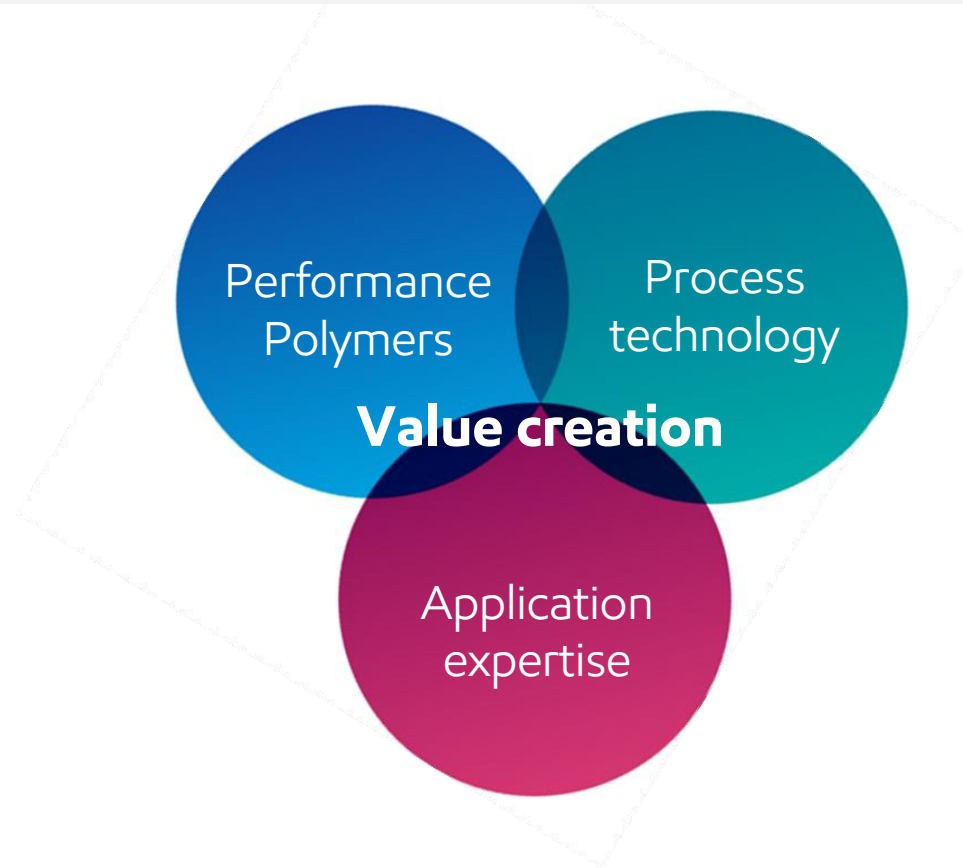
*Recyclable in communities with programs and facilities in place that collect and recycle plastic film.



ExxonMobil

* Recyclable in communities with programs and facilities in place that collect and recycle plastic film

Collaborating with the value chain



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Questions ?



exxonmobilchemical.com/pe

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Test Methods

Test item	Test method
Oxygen transmission rate (OTR)	ExxonMobil test method
Water-vapor transmission rate (WVTR)	ExxonMobil test method
Tensile properties on film at room temperature	ExxonMobil test method
Dart drop impact resistance by free falling dart : method A and B	ExxonMobil test method
Puncture - needle test	ExxonMobil test method
Bag drop test	ExxonMobil test method
Bending stiffness	ExxonMobil test method
Haze	ExxonMobil test method
Gloss 45°	ExxonMobil test method
Heat seal force	ASTM F-88-15
Hot Tack Strength	ASTM D-1921-12
COF film-film	ASTM D1894
COF film-metal	EM method
TD creep resistance	EM method