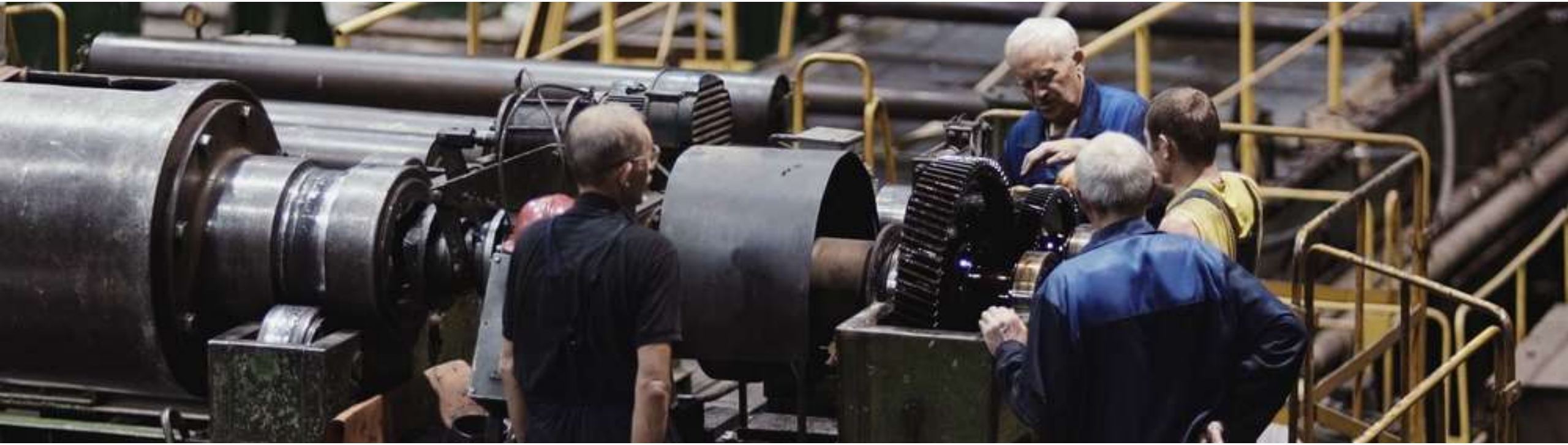
zyfra

How We Learned to Start Cooking High Quality Bitumen and Love the ML in Petrochemical Industry

zyfra.com

Zyfra is all about Industry 4.0 in manufacturing…



Getting legacy machines IIoT ready, increasing OEE 15 – 20% in the process through own devices and software solutions

Oil & Gas, Chemical Production…

Increasing debit of oil wells by 1,5% -2% through pump and watering control

And Metallurgy

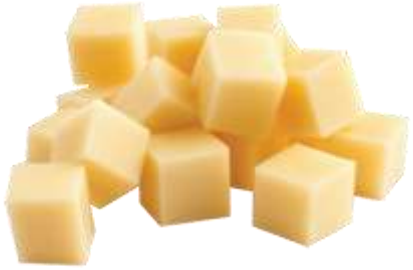
Decreasing steel pipes production defects from 3% to 0.4%

But today we are cooking Bitumen

- **Bitumen** – low-grade of crude oil
- **90%** of bitumen goes to road construction, 8% - to waterproofing products like roofing felt and sealing flat roofs
- Polymer Modified Bitumen (PmB) is at the core of modern road construction
- Road maintenance costs reduced by **60%**
- Overhaul life is growing from **3-4 years to 7-10 years**

Secrets of Gluten-Free 100% Vegan Zero-Lactose Bitumen Formula

Don't Try That at Home



Bitumen

Elastomer

Plastomer

Other licorice-like substances like Sulfur, Tar and etc.

Like different spices create different flavors, varying proportions of the batch components result in different product properties

Secrets of Gluten-Free 100% Vegan Zero-Lactose Bitumen Formula

By varying the proportions of the batch components, we can obtain the required product characteristics

Bitumen

+

Elastomer (SBS)

+

Plastomer (EVA)

+

Other (sulfur, tar and etc.)

How would you like it done?

(Not rare)

Plasticity VS **Elasticity**

Ability to maintain shape after deformation

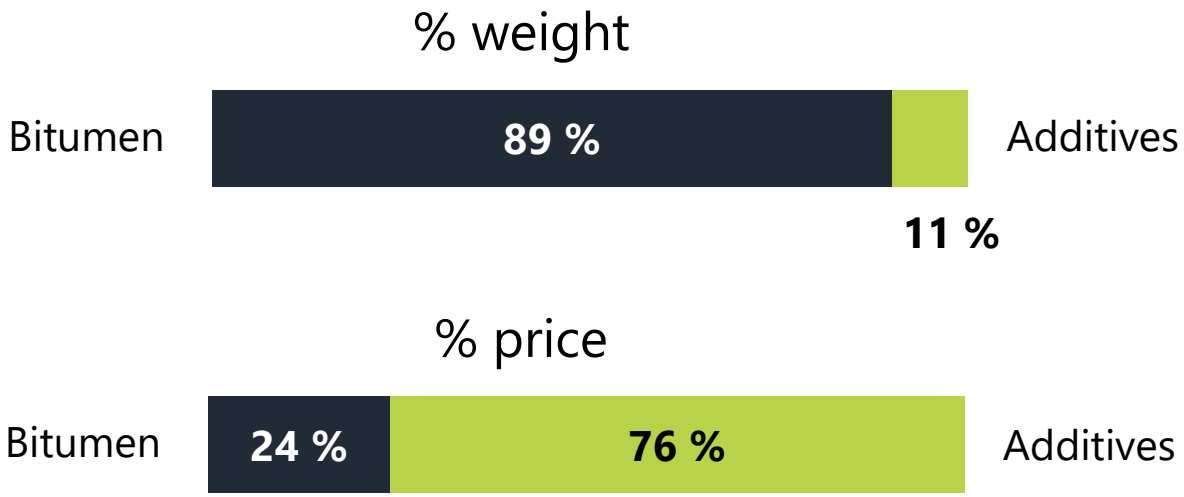
Ability to recover from deformation

Hardness VS **Viscosity**

Ability to resist shape changing under deformation

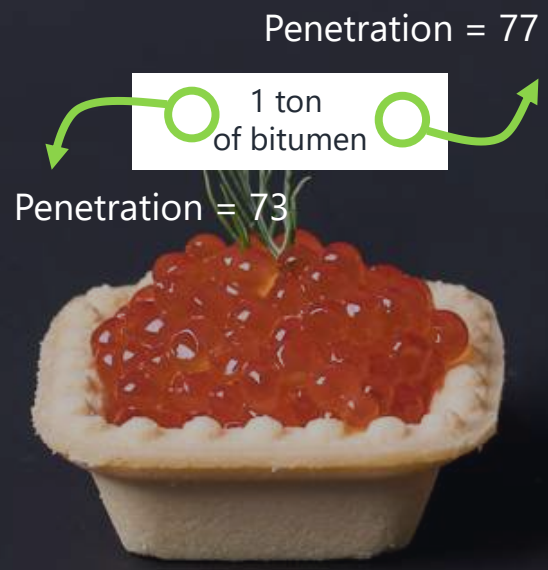
Ability to resist the movement of layers of product

Mixing and Spicing

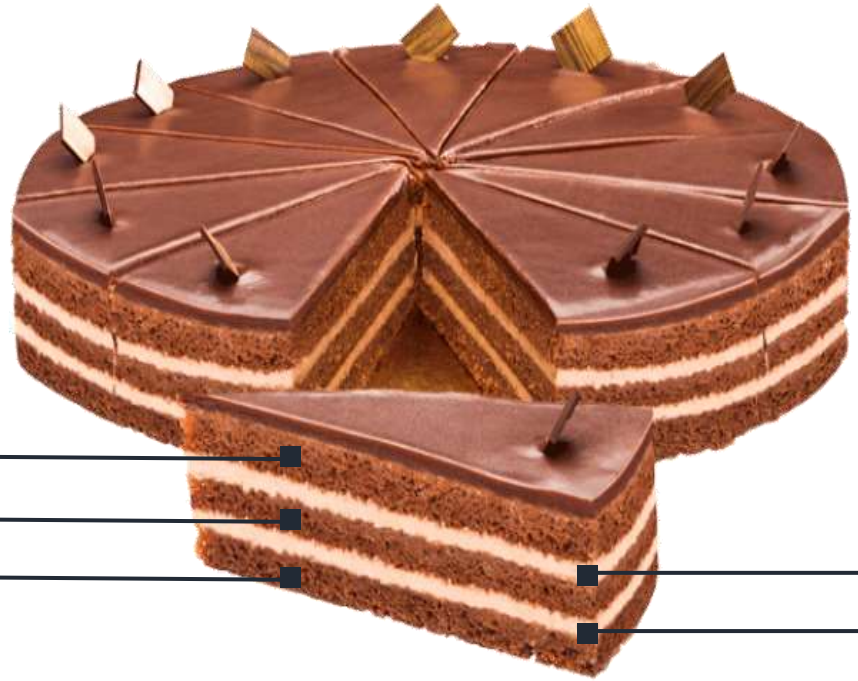


GOAL:
Reduce cost of the product (% of additives) with respect to quality requirements

PROBLEM:
High variability in the characteristics of the feedstock (especially bitumen) due to its organic nature



Zyfra Microservice Cooking Machine Architecture



API
Optimizer
Data Base

Workflow Manager
Predictor

docker + Swagger + python + mongoDB. + conductor

Final recipe. Or is it?

Algorithm

1. Define the starting recipe to build the search grid with. There may be several
2. Build 10 new recipes around each of the starting recipe
3. Send all new recipes from p.2 to Predictor for getting quality estimation
4. Select top 10% best recipes based on target function

p.2-4 are executed iteratively until the optimal value of target function is found or the searching procedure gets to iterations limit

Predictor

A la carte

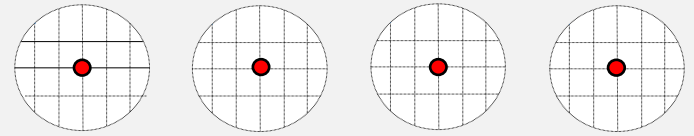
Predictor – service for getting predictions of PmB characteristics based on proportion of components in recipe and characteristics of feedstock

- 1147 batches of PMB
- 3 targets – Penetration 25°, Penetration 0°, Softening point
- Models – Random Forest, Ridge

Optimizer – The real ML cookbook

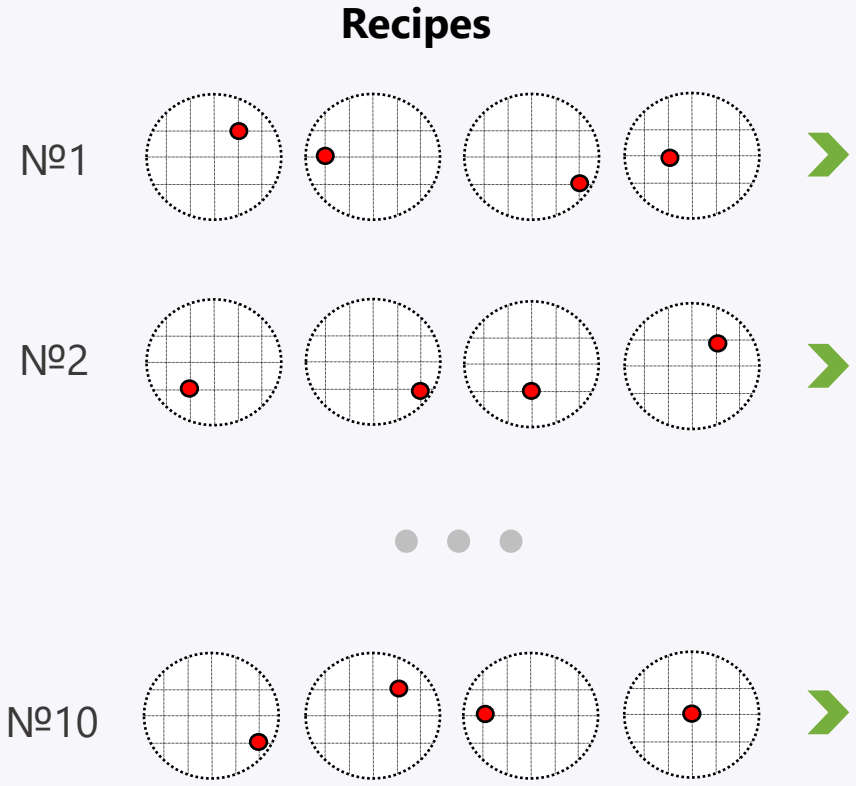
Starting recipe

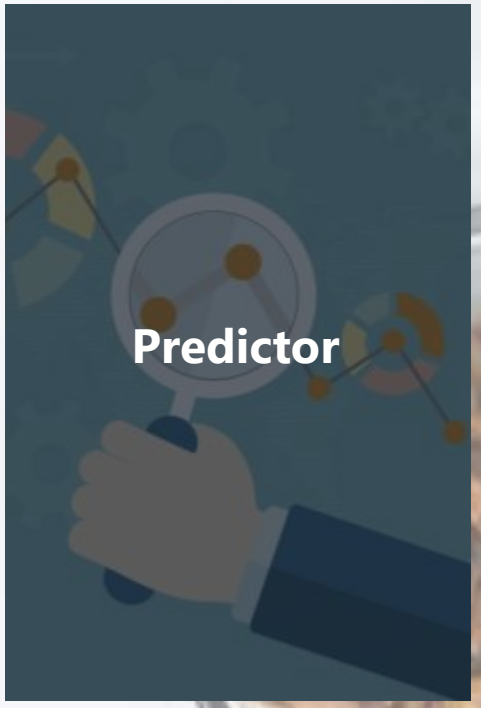
comp_1 comp_2 comp_3 comp_4



	Recipe №1	Recipe №2	Recipe №3	Recipe №10
comp_1				
comp_2				
comp_3				
comp_4				

Optimizer





	Predictions	Intervals probabilities
P25	73,25	0,972
P0	33,11	0,821
P25	69,21	0,78
P0	34,71	0,963
P25	66,17	0,573
P0	35,83	0,773

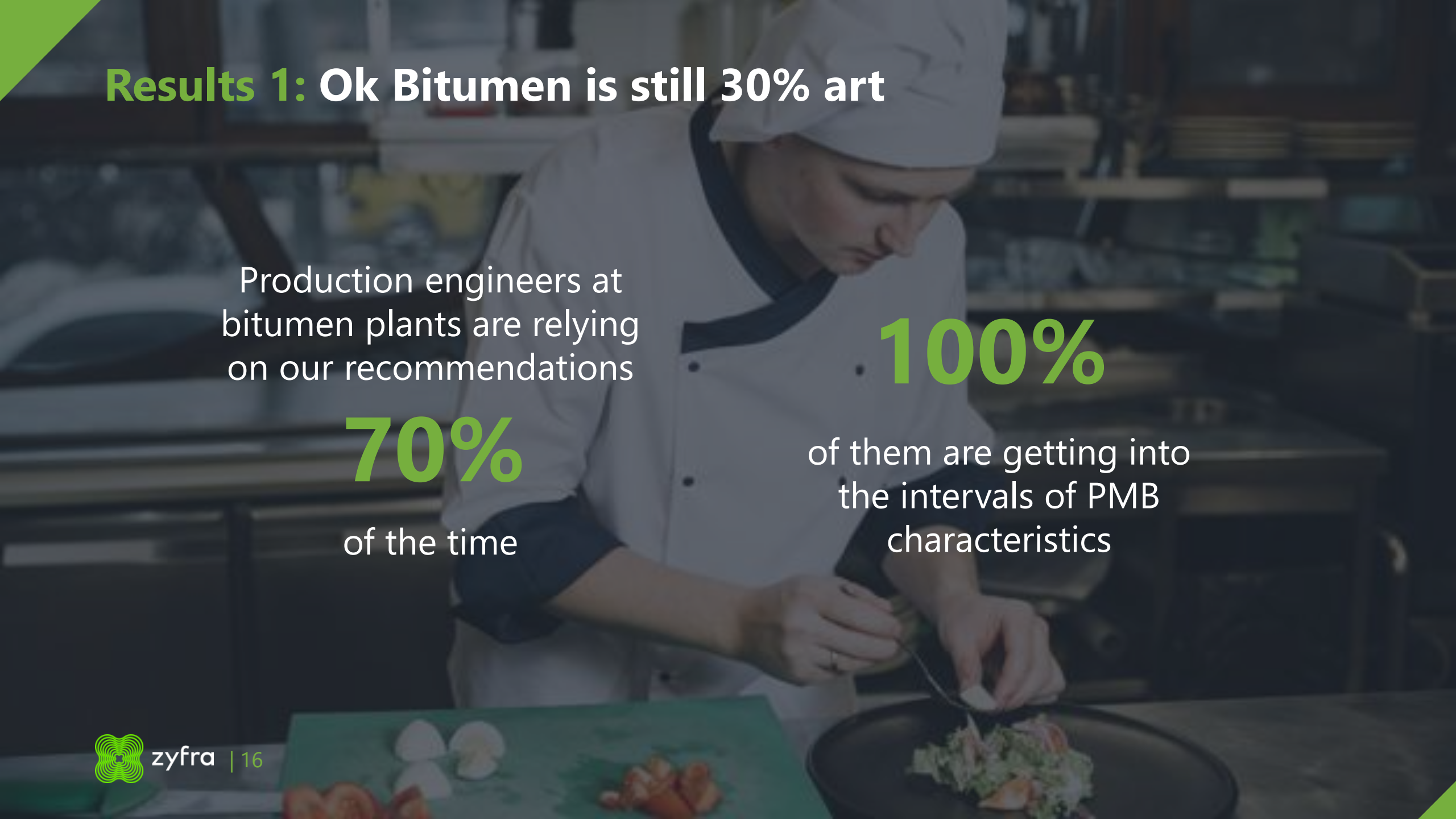
Cooking Bitumen is not art. It's math!

Target function

$$Q = \sum_i price(comp_i) \cdot mass(comp_i) + \mathrm{Z} \cdot \max(P\ (feat_i < limFeat_i))$$

- Z – balancing coefficient between cost and risk
- $P\ (feat_i < limFeat_i)$ – probability of not getting into interval for i-th PMB characteristic
- $price(comp_i)$ - price of i-th component
- $mass(comp_i)$ - mass of i-th component

Results 1: Ok Bitumen is still 30% art



Production engineers at bitumen plants are relying on our recommendations

70%

of the time

100%

of them are getting into the intervals of PMB characteristics

Results 2: PMB production costs decreased by 3.5%

This means our client can afford around

95 000

pizzas each year

Or Italy could build additional

300 km

of highway class roads each year. With the spare Bitumen

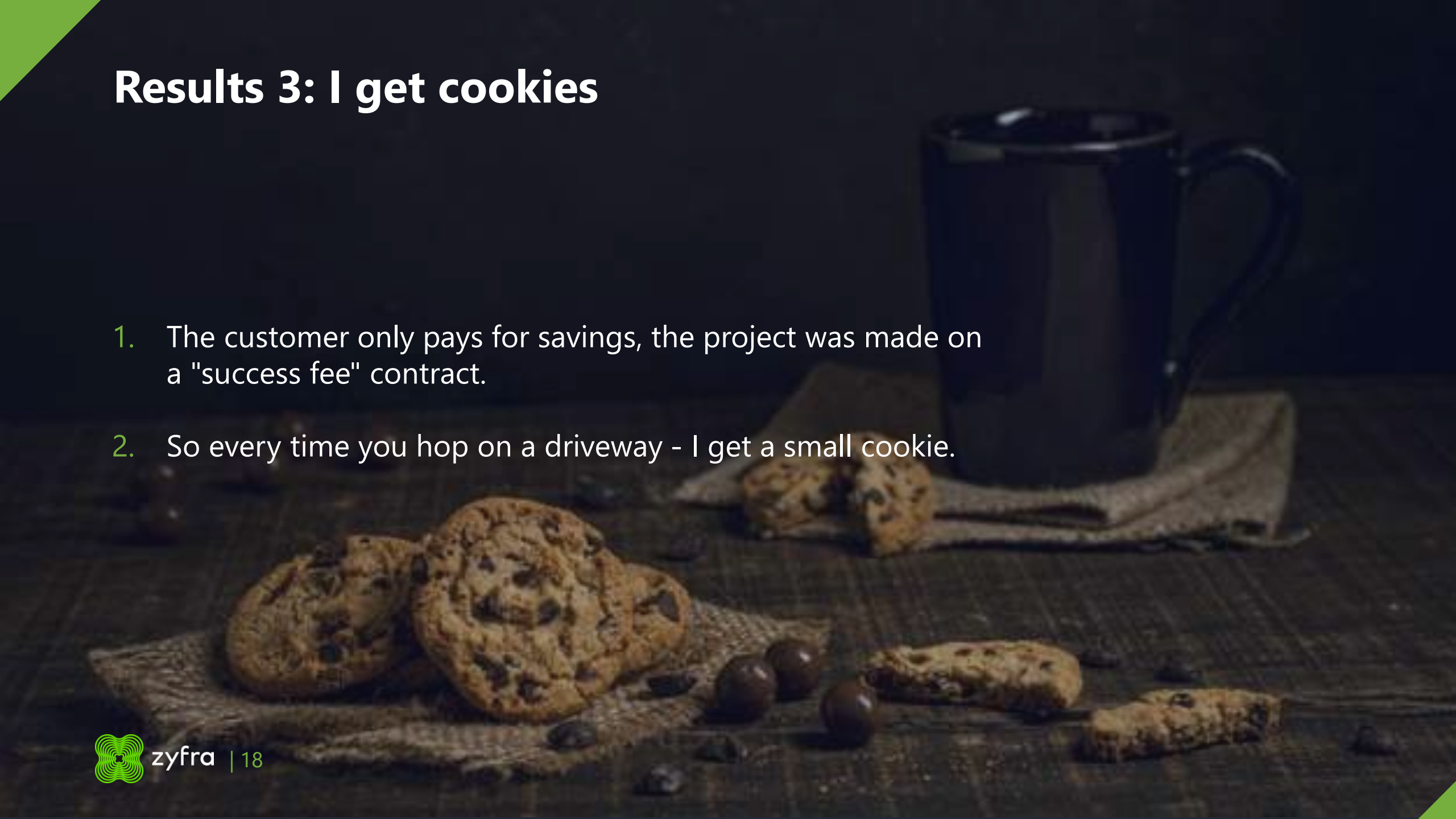
Or you could cover roofs of

18%

of houses in Barcelona with fresh waterproof elastic Bitumen

I would go for pizza!

Results 3: I get cookies



1. The customer only pays for savings, the project was made on a "success fee" contract.

2. So every time you hop on a driveway - I get a small cookie.

Thank you for your attention!
Questions?

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