Finding efficiencies in the HIV response
An overview

To find efficiencies and improve the HIV response, we need to focus on WHAT and HOW

WHAT: allocative efficiency

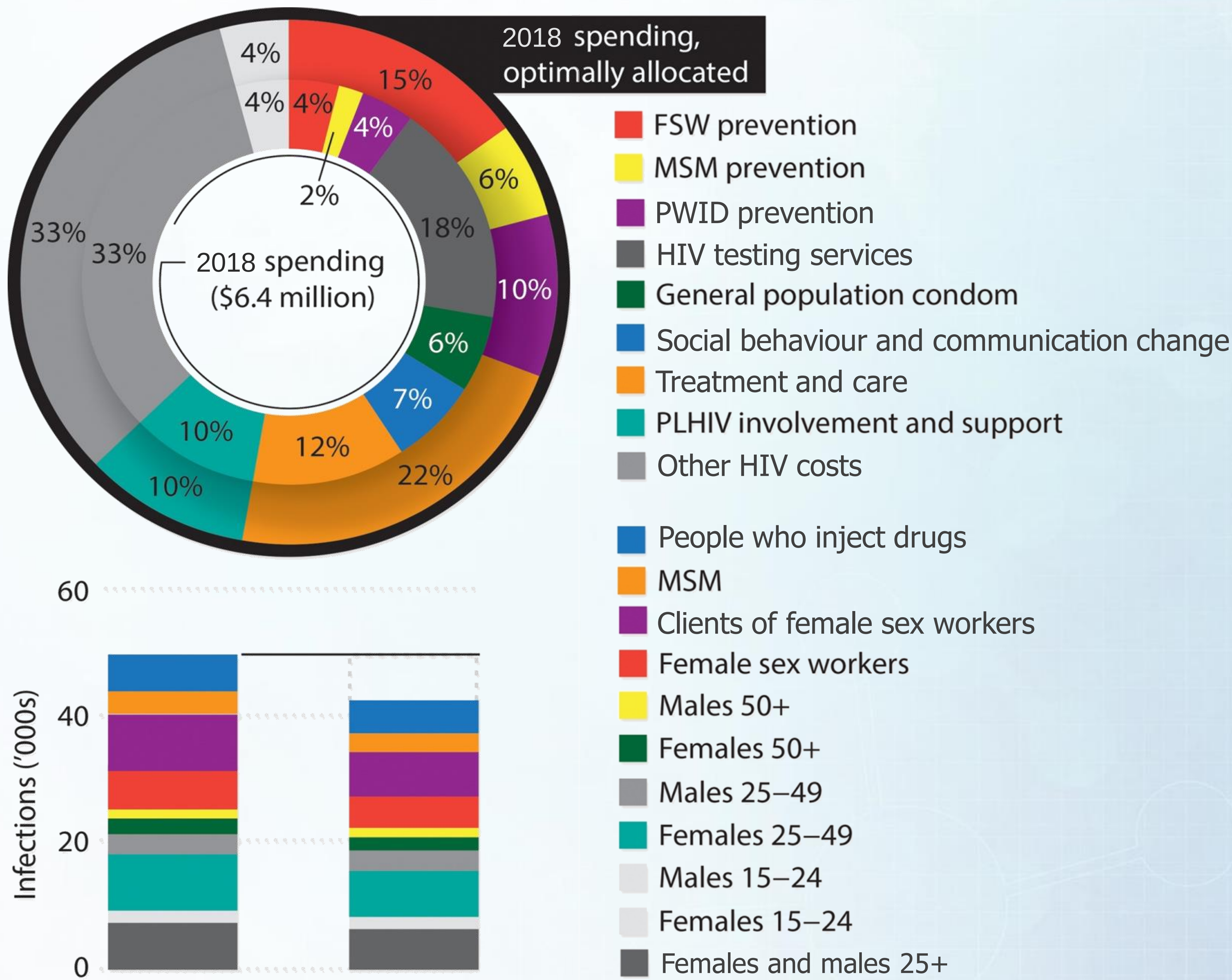
- Redistribute resources across a mix of programs to maximize gains
- Provide the:
  - right interventions to the
  - right people in the
  - right place at the
  - right time

  to maximize outcomes for a given level of resources

Ways to improve the ‘WHAT’: allocative efficiency

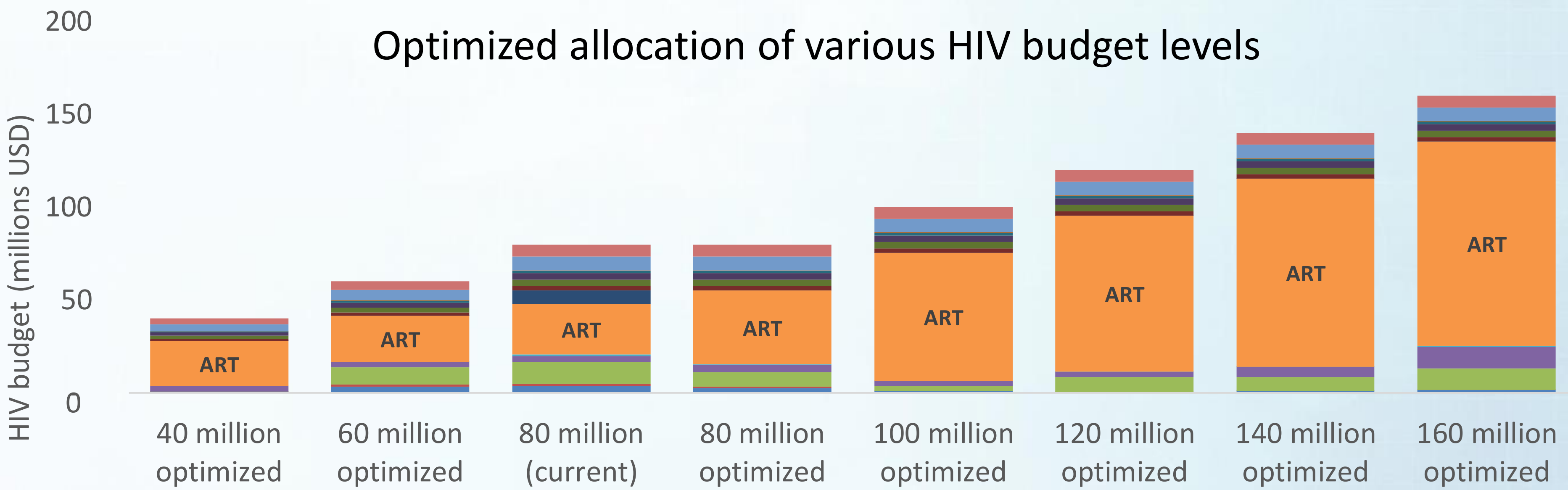
1. Analyze changes in epidemiological trends and use benchmarking between contexts
2. Use mathematical modelling and cost-effectiveness analysis

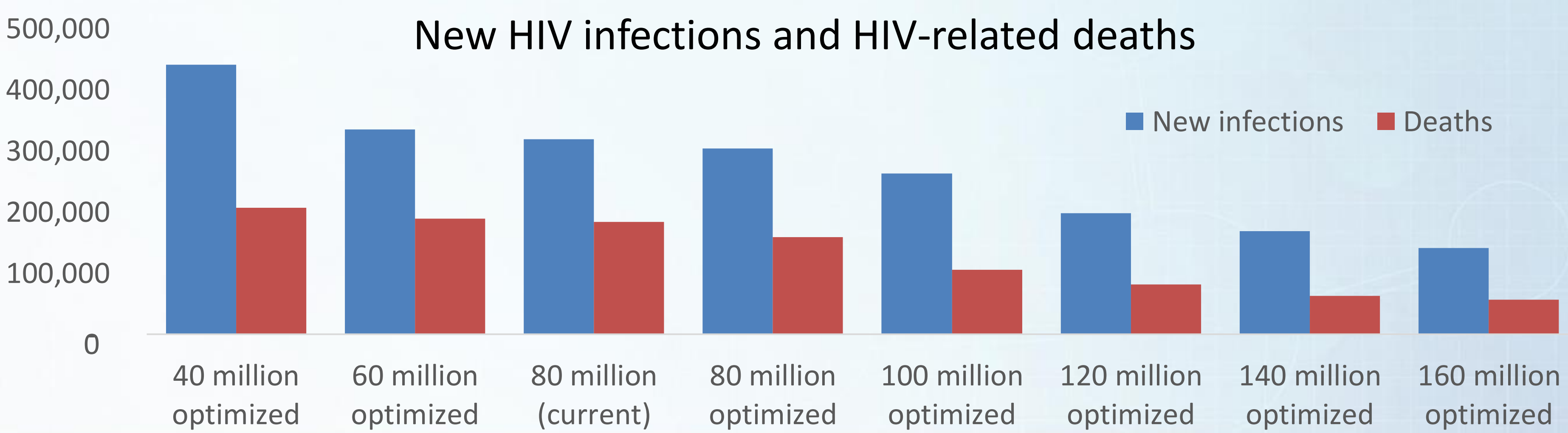
Estimate the optimized HIV resource allocation



Optimization under varying HIV budget

- With **less money**, what is essential to protect?
- With **more money**, which next most cost-efficient program should be scaled-up?



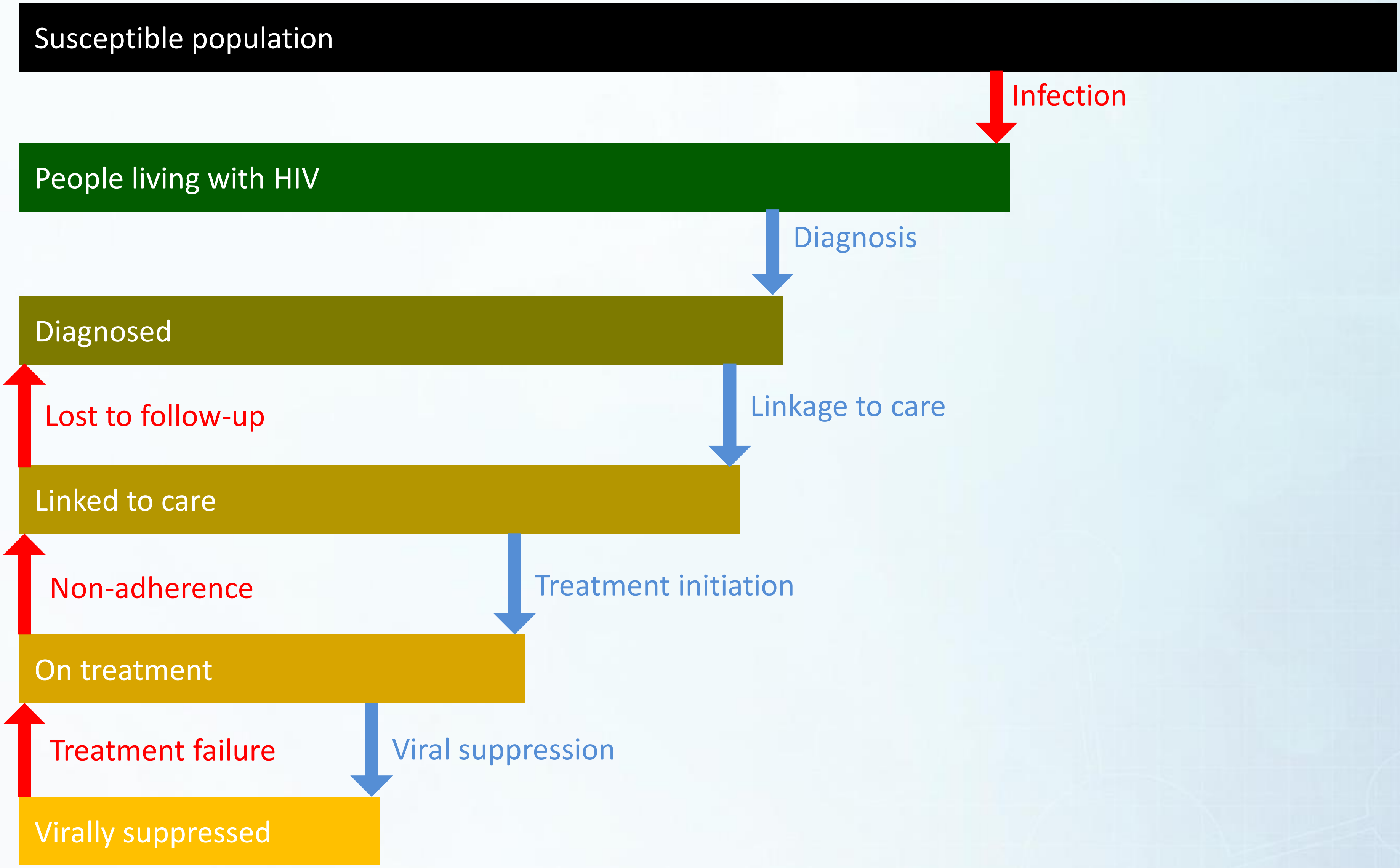


HOW: implementation efficiency

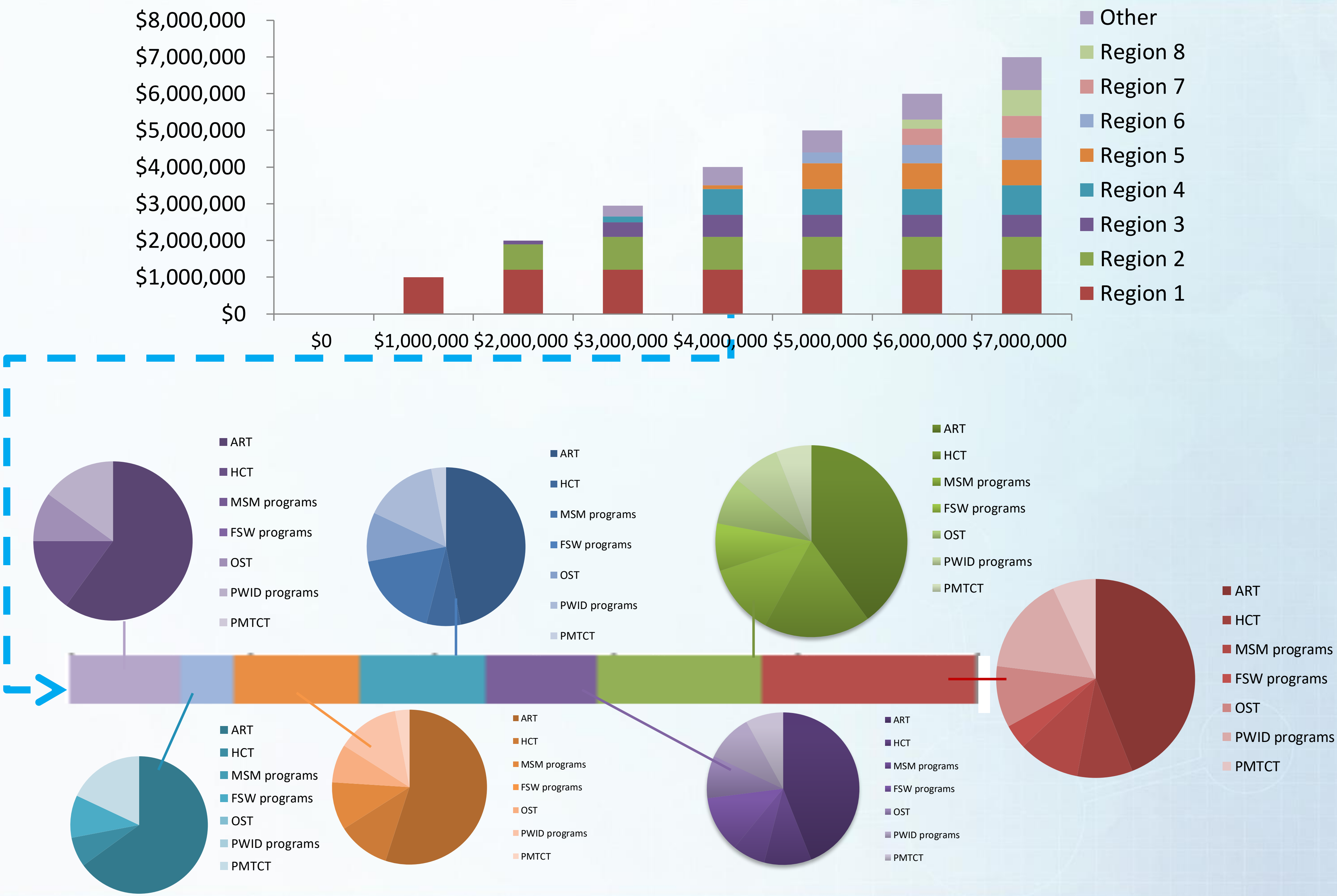
- Cascade analysis
- Geographical prioritization
- Improve implementation
- Management assessments
- Benchmarking
- Supply and demand analysis (out-of-scope)

Identify improvements for HIV service delivery

Cascades can help identify and address bottlenecks



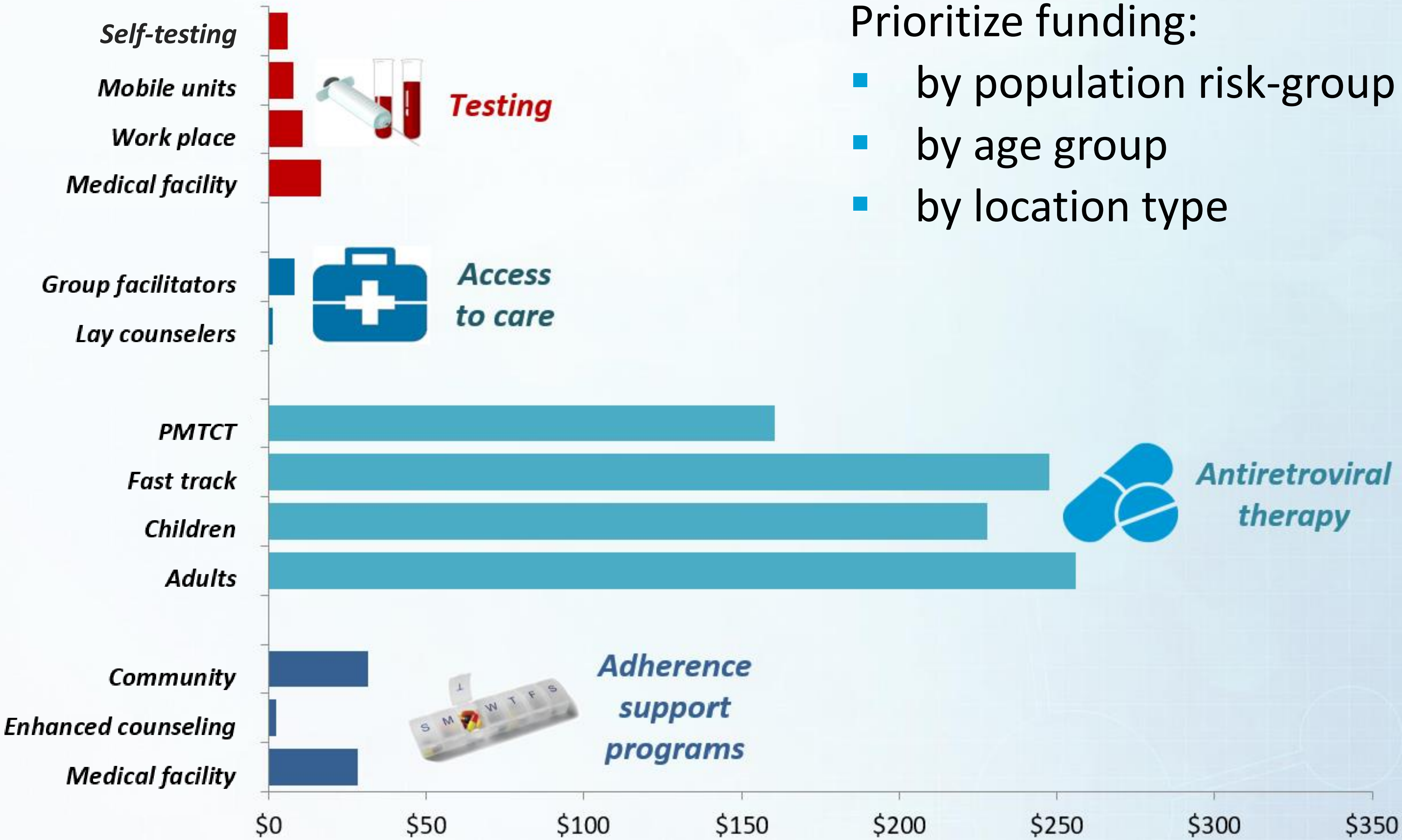
Geographical prioritization using Optima HIV



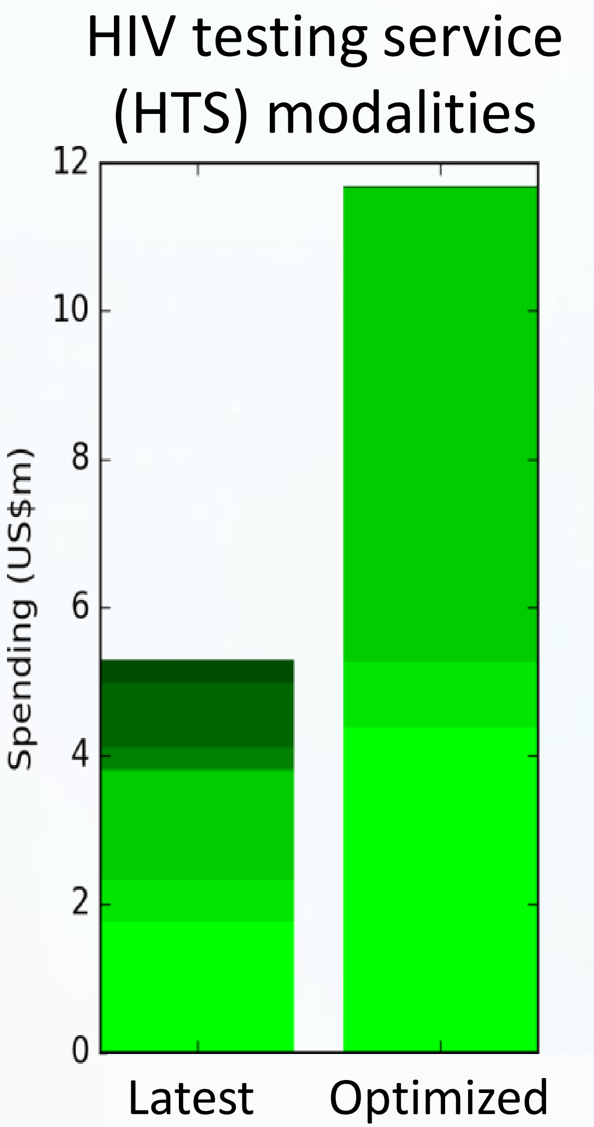
Allocative and implementation efficiency

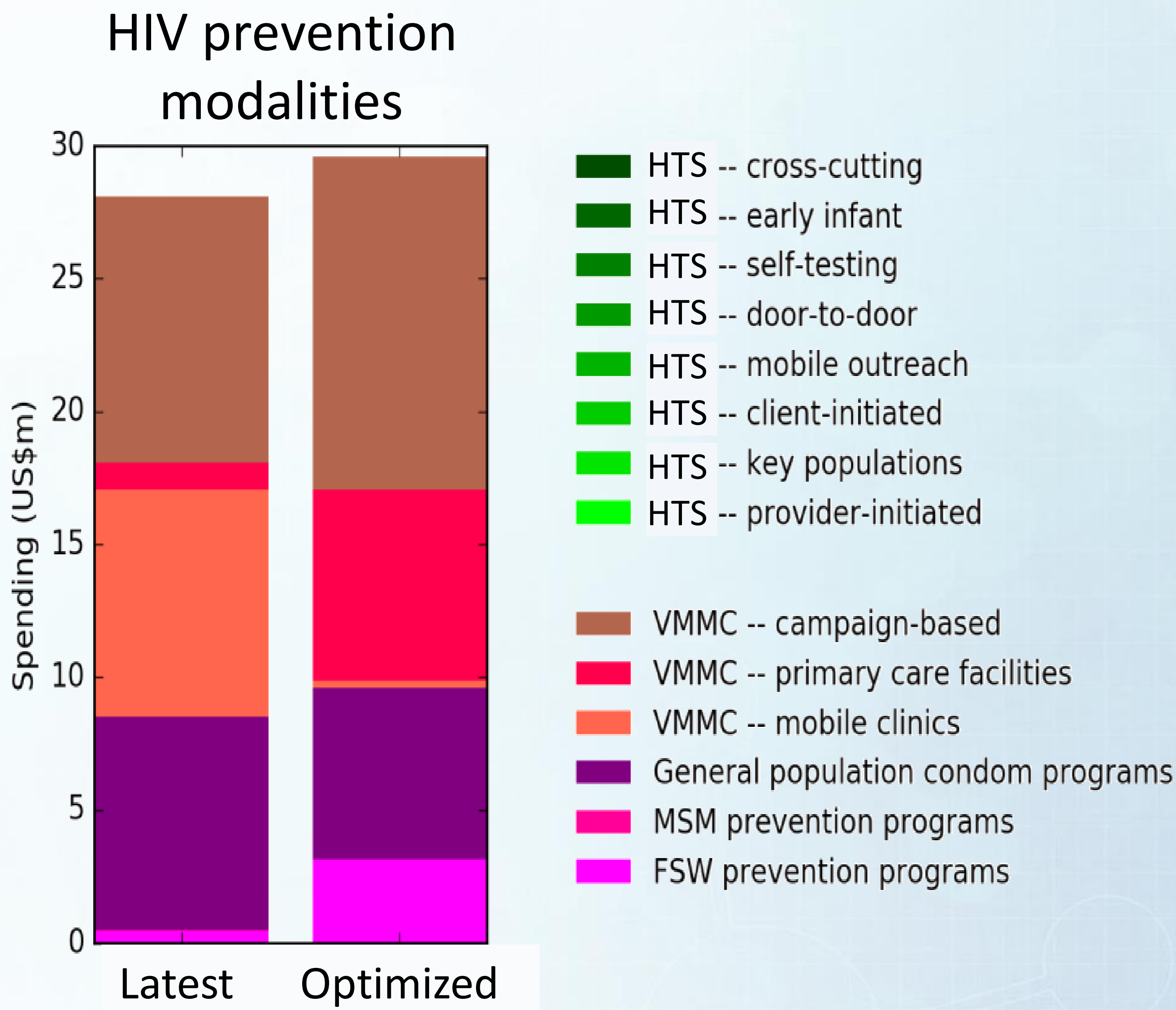
Prioritize funding:

- by population risk-group
- by age group
- by location type



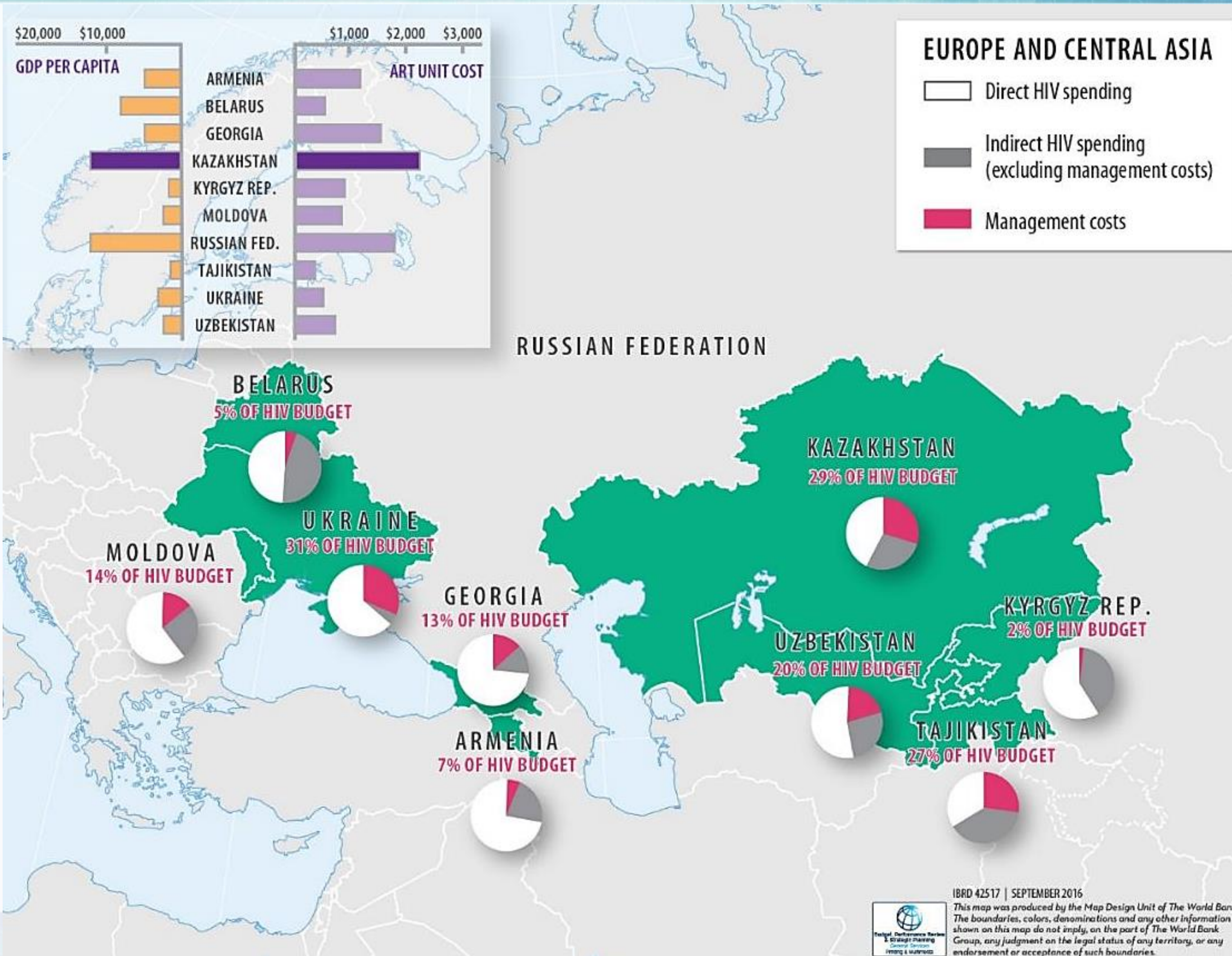
Improve implementation efficiency by prioritizing most effective HIV service delivery modalities





Source: World Bank. 2017. Improving the allocative efficiency of Malawi's HIV response: Findings from a mathematical modeling analysis. Washington DC: World Bank.

Management assessment and benchmarking



Introduction to Optima HIV

Optima is a tool to help decision-makers, program managers, and funding partners **achieve maximum impact** with the **funding available** for the country’s public **health response** and plan for sustainability

For the right people in the right places at the right time in the right ways.

The Optima approach

Burden of disease

- Epidemic model
- Data synthesis
- Calibration / projections

Programmatic responses

- Identify interventions
- Delivery modes
- Costs and effects

Objectives and constraints

- Strategic objectives
- Ethical, logistic, and/or economic constraints

Scenario analysis

Optimization

Projected health and economic outcomes

Overview of HIV models

Comparison of HIV epidemic model characteristics	Approach	Populations	Purpose	Inputs	Outputs
Estimation and Projection Package (EPP) *(combined with Spectrum)*	Fits four parameters to a simple model; written in Java	MSM, PWID, FSW, male SW, CSW, and low-risk (separated into urban and rural)	Estimate and project adult HIV prevalence and incidence	Size of subpopulations; HIV prevalence among subpopulations; treatment data	Current number of HIV infections; HIV infection trends (5-year projections)
AIDS Epidemic Model (AEM)	Semi-empirical process model; written in Java	PWID, direct FSW, indirect FSW, MSW, CSW, and MSM	Provide a policy and planning tool for Asian countries	Size of subpopulations; HIV and STI prevalence; risk behavior data; average duration in each population	Trends of HIV infections; impacts on AIDS cases, ART needs, deaths, etc. (long term projections)
Mode of Transmission (MOT)	Risk equations; written in Excel	PWID, FSW, MSM, and low-risk (separated into males and females)	Calculate expected number of infections over coming year	HIV prevalence; number of individuals with particular exposure; rates of exposure	Incidence (HIV acquisition) per risk group
Goals / Spectrum	Compartmental rate-based model; written in Visual Basic	MSM and high, medium, and low-risk groups	Estimate costs and impact of different interventions	Sexual behavior by risk group; demographic data; base year human capacity	Costs; HIV prevalence and incidence (5- year projections)
Optima	Compartmental rate-based model; written in Python	Flexible; unlimited but usually around 8-20 groups, including key affected and general populations and different age groups	Analyze and project HIV epidemics; determine optimal resource allocations	Size of population groups; HIV and STI prevalence; risk behavior data (e.g. condom use); biological constants (e.g. background death rates)	HIV prevalence and incidence trends; healthcare costs; deaths; optimal resource allocations

Source: Kerr et al. Optima: A Model for HIV Epidemic Analysis, Program Prioritization, and Resource Optimization, 2015 JAIDS, 69(3): 365-76

Addressing objectives using Optima HIV

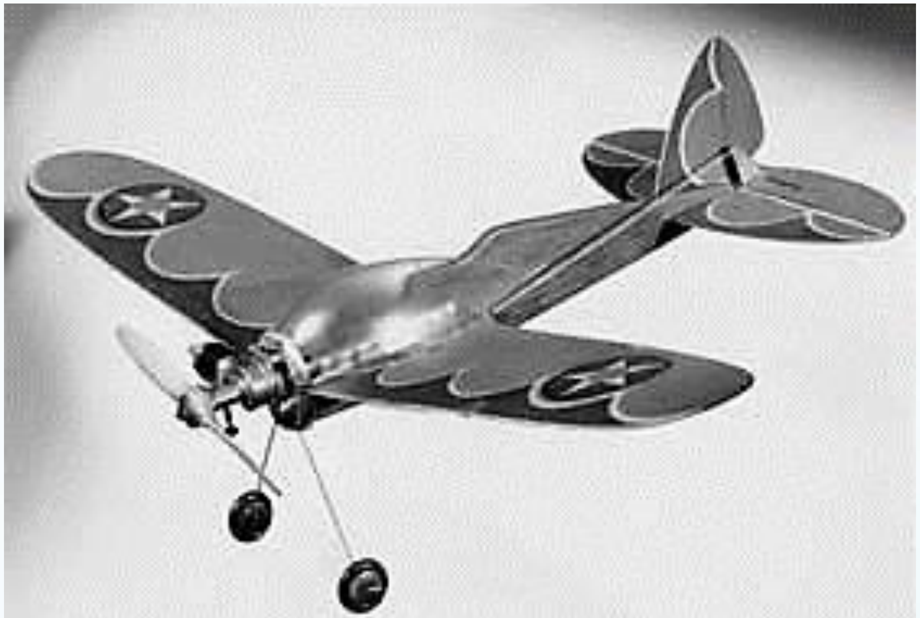
- What health benefits can be achieved if resources are optimally allocated? For example, how many:
  - new HIV infections
  - HIV-related deaths
  - DALYs

  can be averted?

- Optima HIV analysis can help inform strategies to achieve HIV-related objectives
  - Optima HIV is an efficiency analysis tool
  - Optima HIV is *not* a budgeting tool

How does Optima HIV work?

Optima HIV is a model

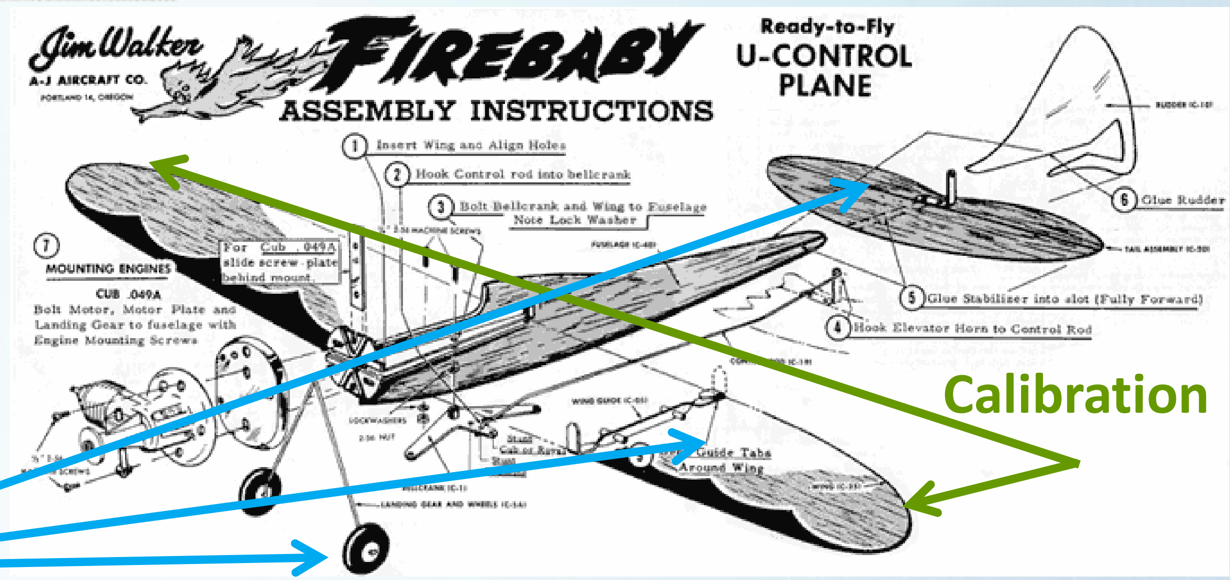


Outcome: how many people can we safely fly in this plane?

How much further could the plane fly if program $ allocation is **optimized**?

Scenario: *what if* we increased the size of wings?

Epidemic: type of model
Populations: passenger groups
Programs: piloting, flight service, maintenance, etc.
Spending: programs & parts $s
Optimization of $



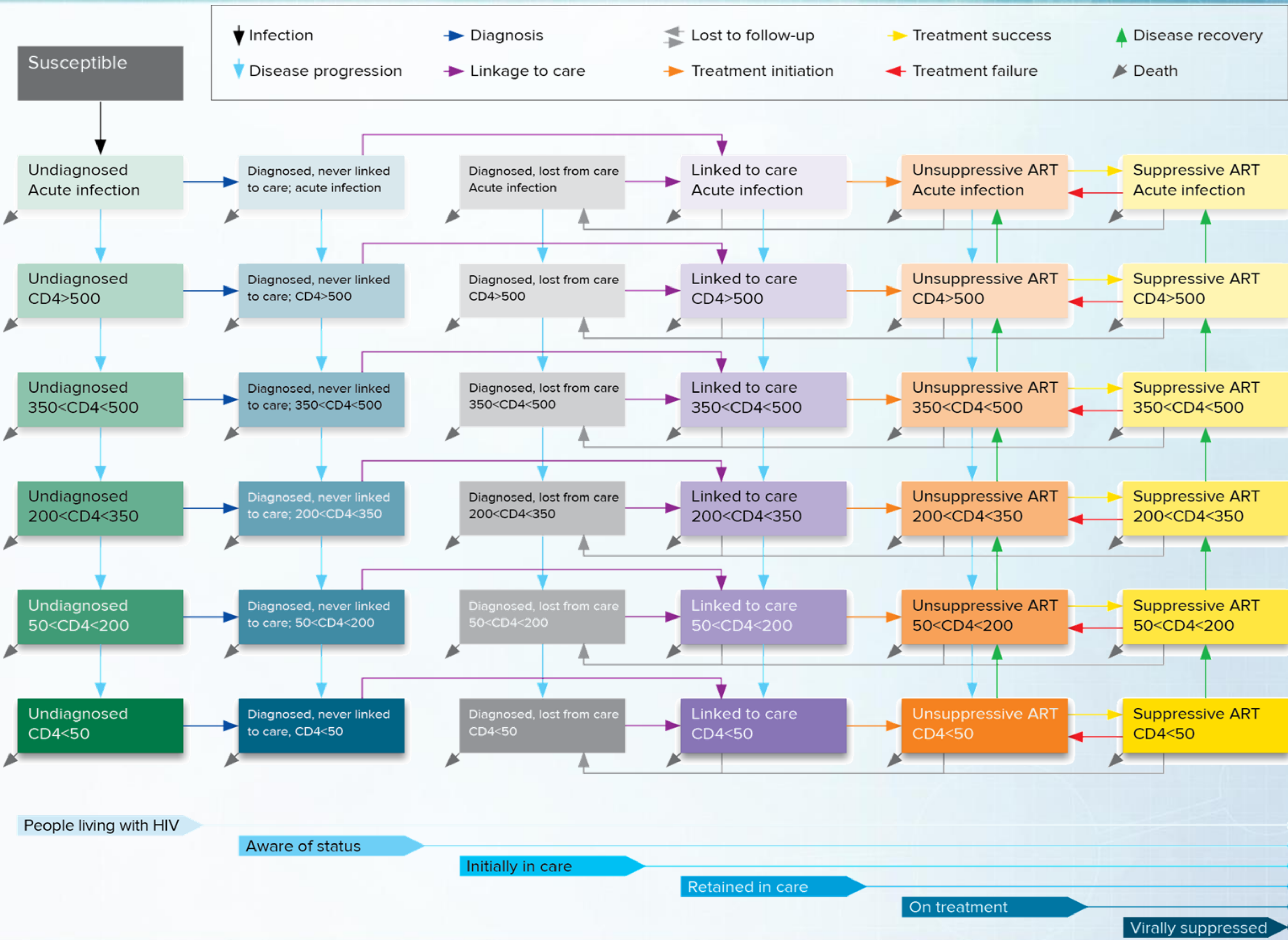
Epidemiological component

- Optima HIV is a dynamic compartmental **population-based** model

- The population is divided into compartments based on:
  - user-defined criteria
    - age, sex, risk behavior, location, etc.
  - health states across the HIV cascade

- At each time point, people can move between health states (i.e. compartments)

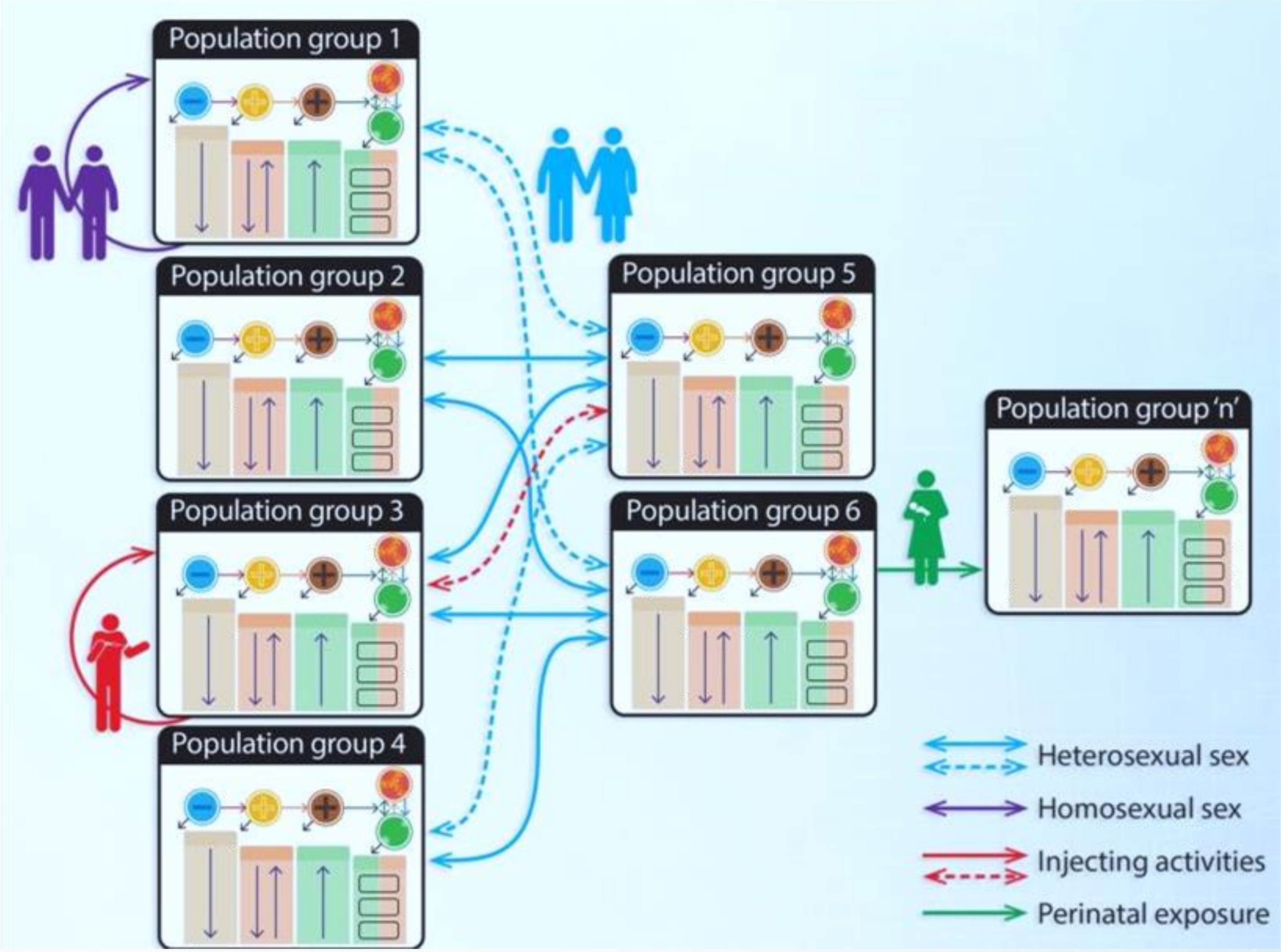
Compartmental Optima HIV model structure



HIV transmission between populations

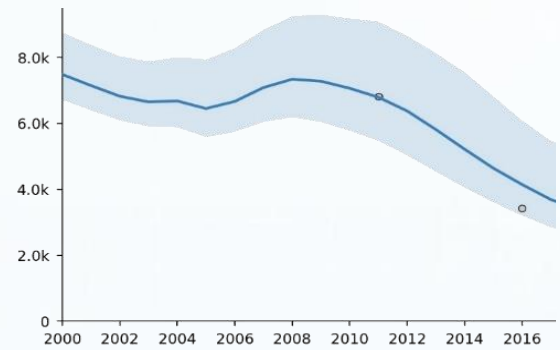
The model tracks:

- HIV disease progression for each population group
- Viral transmissions between populations (i.e. partnerships)

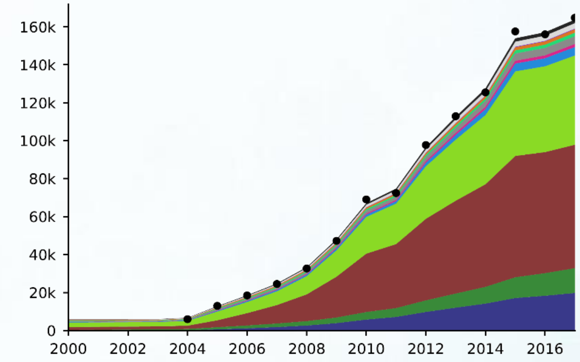


Model calibration

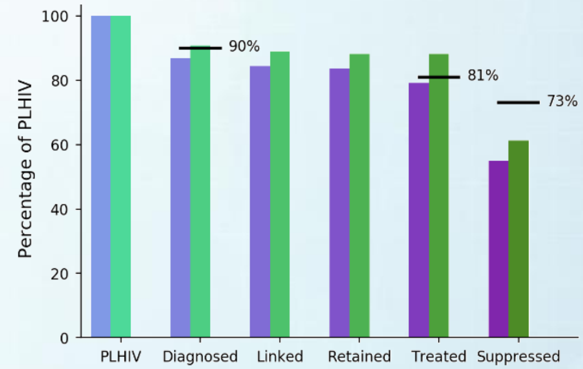
People living with HIV (PLHIV)



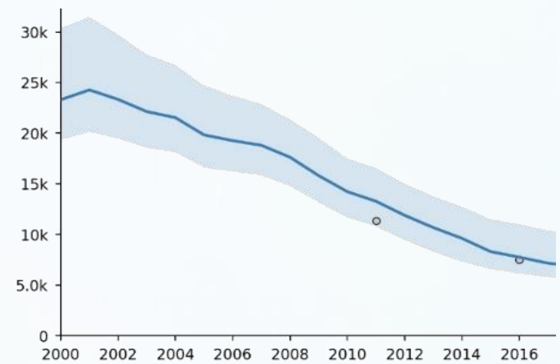
PLHIV on treatment



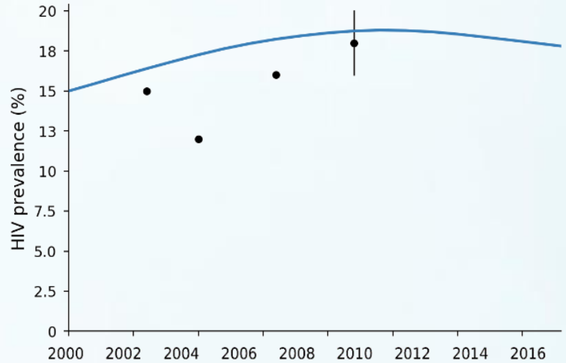
Care cascade



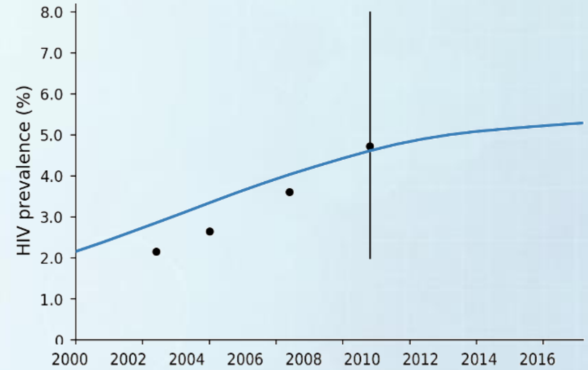
New HIV infections



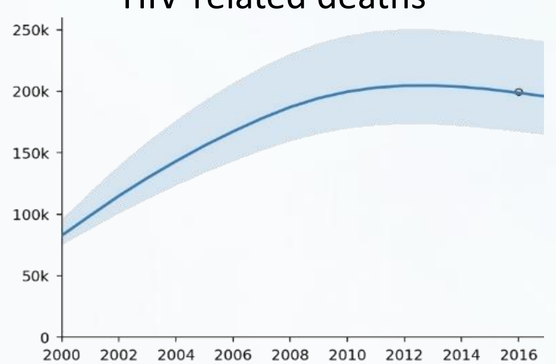
Prevalence PWID



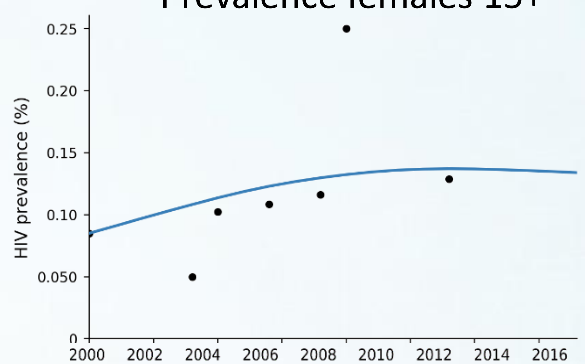
Prevalence MSM



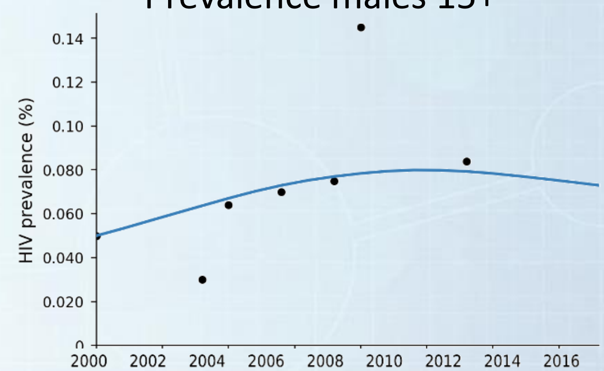
HIV-related deaths



Prevalence females 15+



Prevalence males 15+



MSM: Men who have sex with men. PLHIV: People living with HIV. PWID: people who inject drugs

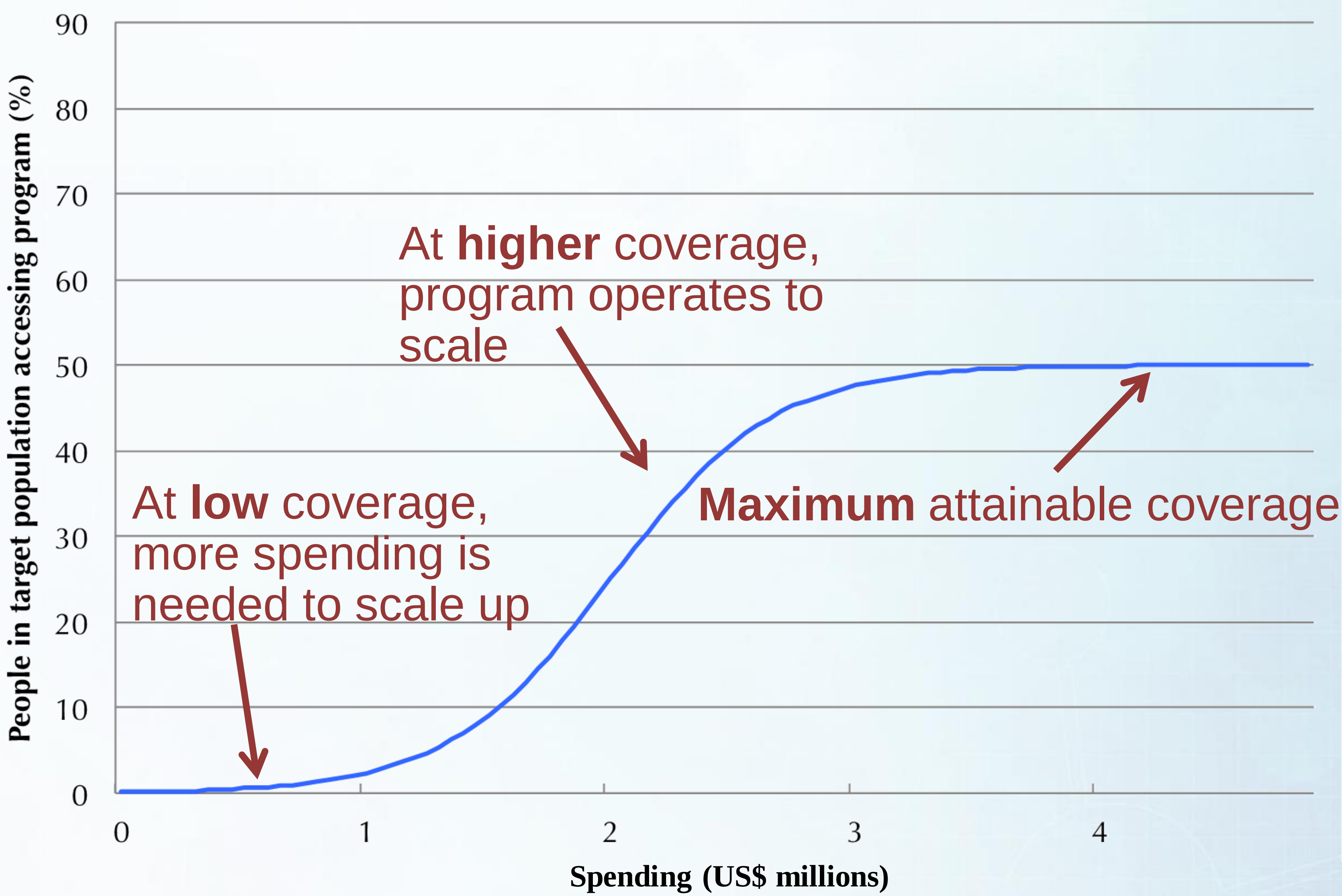
HIV programs

- HIV programs can be:
  - **Targeted programs**: direct impact on the HIV epidemic
  - **Non-targeted programs**: direct impact on the HIV epidemic cannot be measure, not considered within the optimization

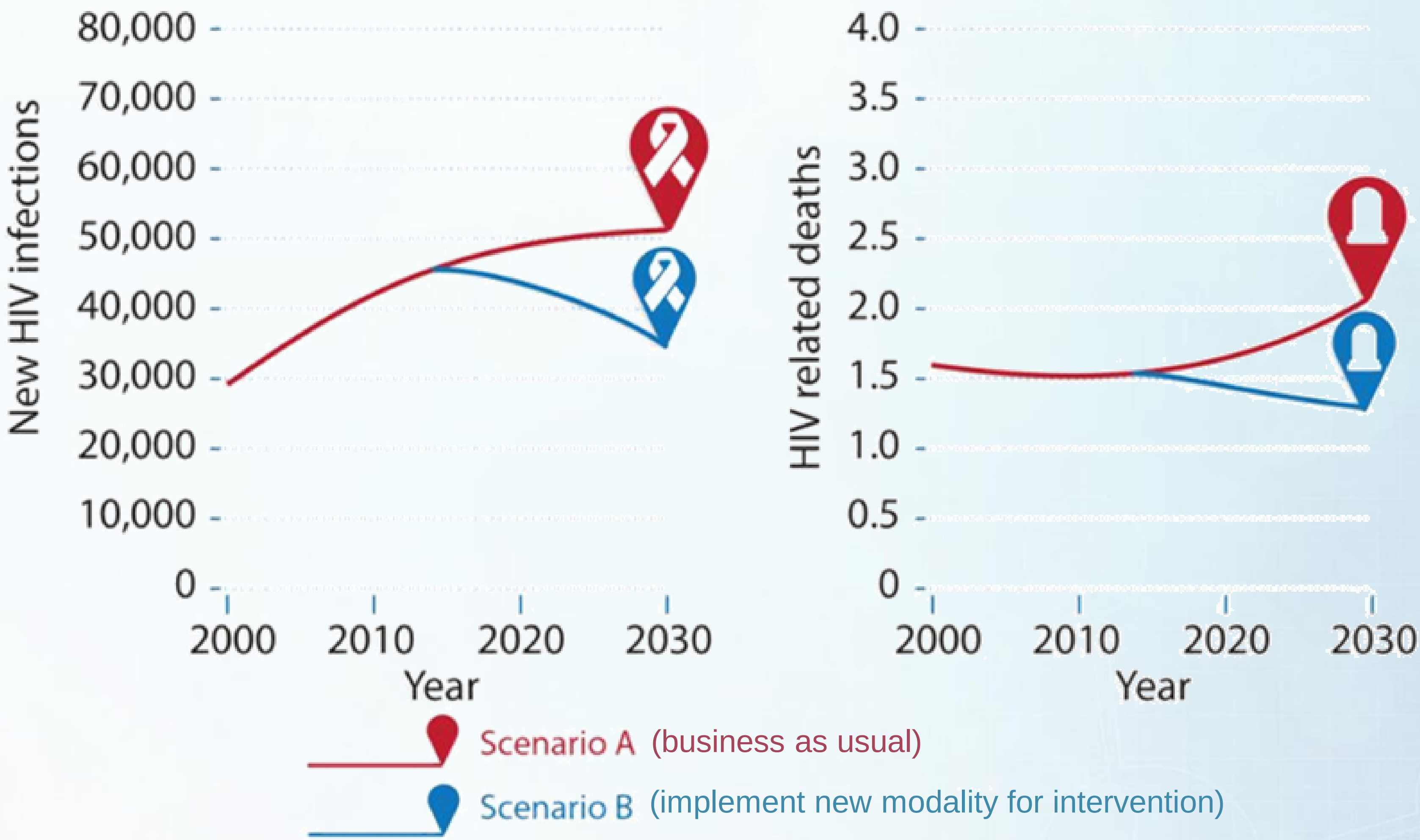
- Data needed, for most recent year (or 3 most recent years):
  - program spending (cost, unit cost)
  - program coverage

- Cost functions link:
  - program spending to program coverage
  - program coverage to program outcome

Cost functions: cost-coverage curve



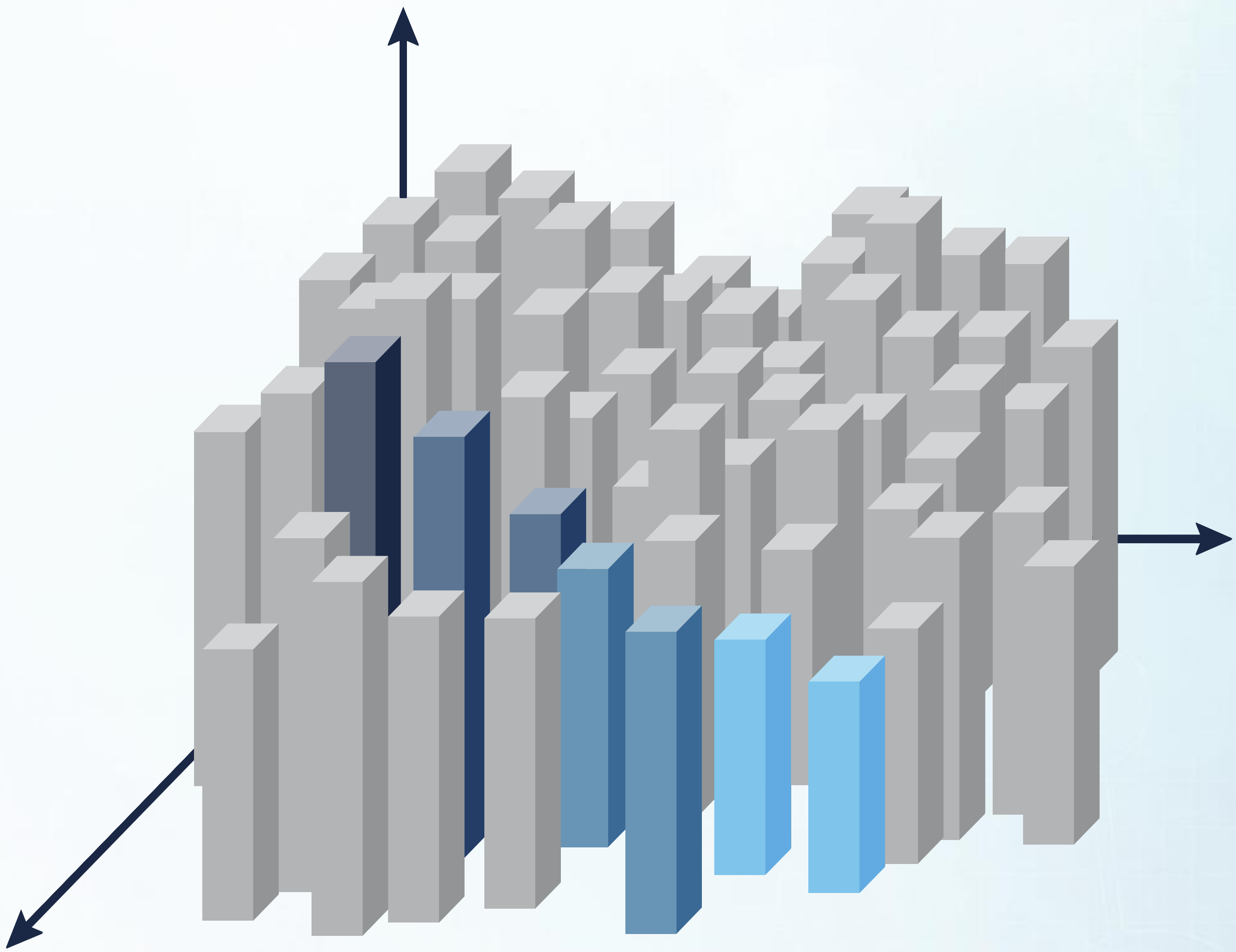
Scenario analysis



Optimization analysis

How should the budget be allocated amongst these ‘n’ programs, modalities, and delivery options, considering their interactions with synergies and limitations to best meet objectives?

Optimization: consider just two dimensions



An efficient **A**daptive **S**tochastic **D**escent algorithm is applied

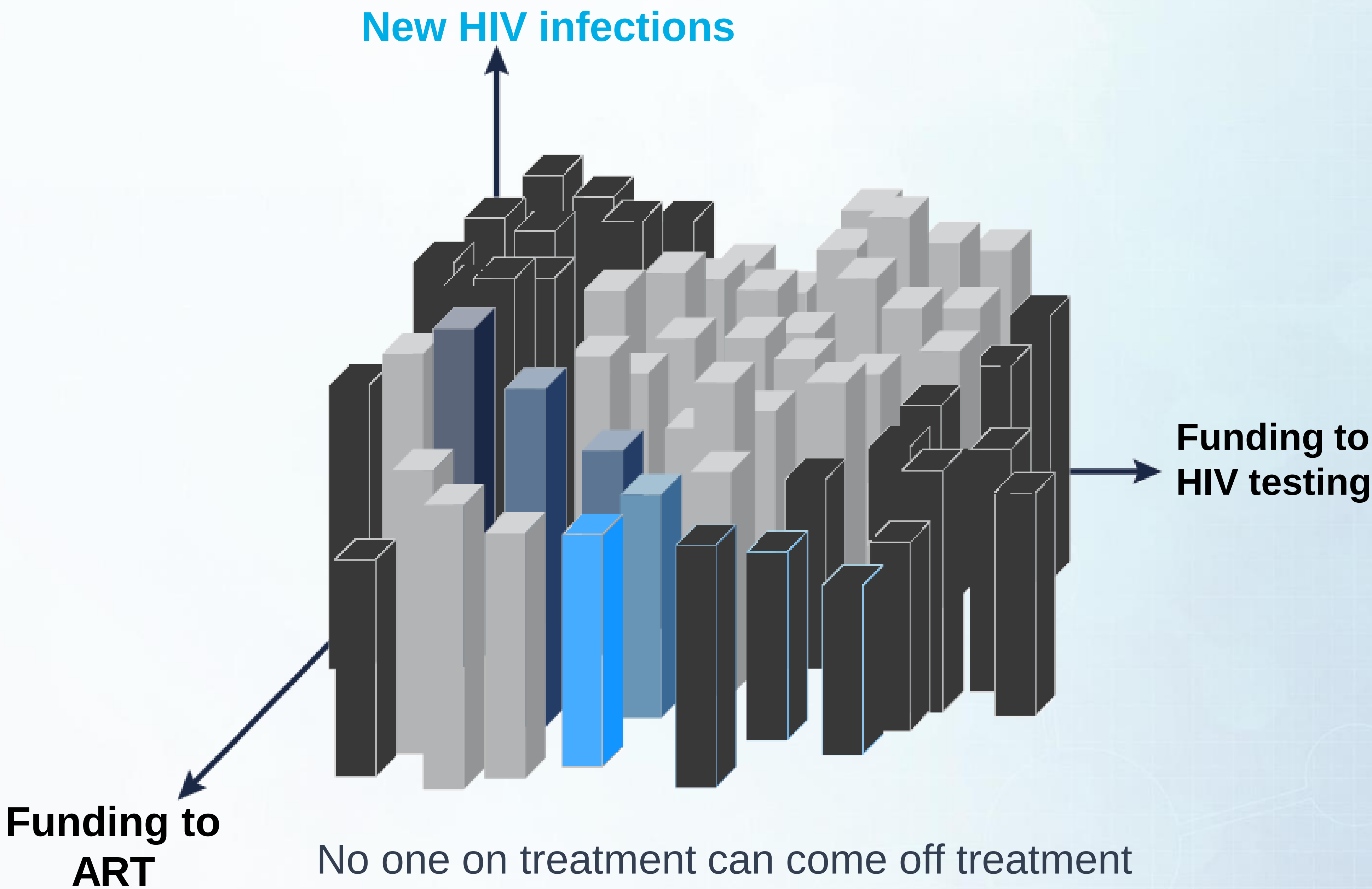
Adaptive: learns probabilities and step sizes

Stochastic: chooses next parameter to vary at random

Descent: only accepts downhill steps

Source: Kerr et al. (2015) Optima: A Model for HIV Epidemic Analysis, Program Prioritization, and Resource Optimization, JAIDS, 69(3): 365-76.

Constraints: ethical, economic, logistic, political



No one on treatment can come off treatment

Model specifications

- Time horizons (reference year, etc.)
- Population groups
- Programs and modalities
  - Cost
  - Coverage
  - Target groups
  - Characterization of each intervention
  - Parameters affected
  - Saturation
  - Efficacy
- Define objectives: set-up scenarios, optimizations
- Constraints: eg, no one on treatment removed
- Model constants
- Critical data gaps and strategies to fill them
  - Additional data collation, secondary data or sensitivity analysis, proxies, etc.

Objective 1

Given past resource allocation,
for 2015-2017,
how many new HIV infections and HIV-related deaths are estimated to have been averted and QALYs gained through HIV program implementation?

Evaluating HIV programs in Vietnam, 2003-2012

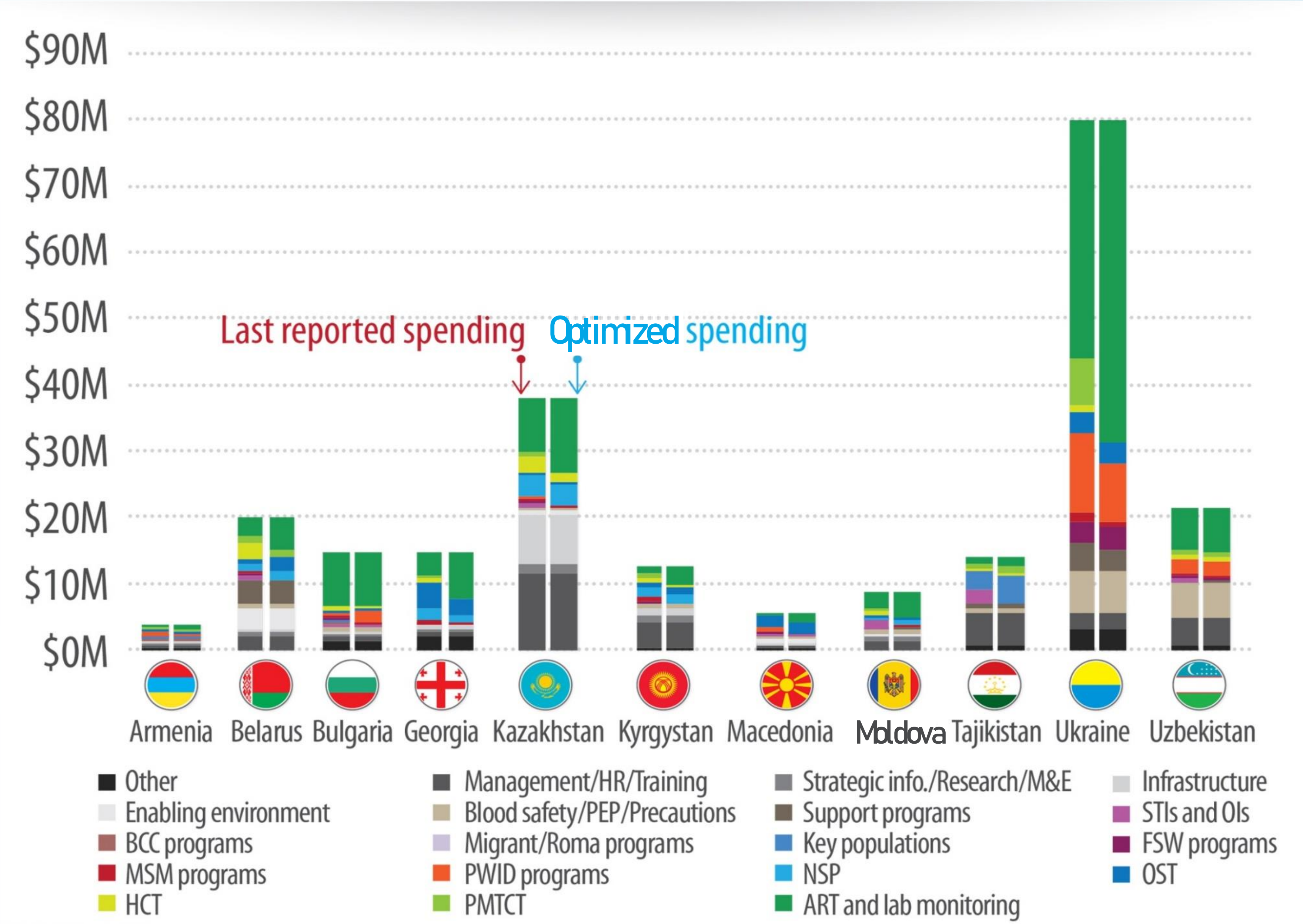
- Estimated that 2003-2012 **programs averted:**
  - 33,000 HIV infections
  - 900 HIV-related deaths
  - 17,400 DALYs
- Most benefits from needle-syringe exchange program
- Costs:
  - US$1,000 per HIV infection averted
  - US $36,000 per HIV-related death averted
  - US $1,900 per DALY averted
- According to standard willingness-to-pay thresholds, programs are **good value** for money

Program support from Department for International Development and the World Bank

Objective 2

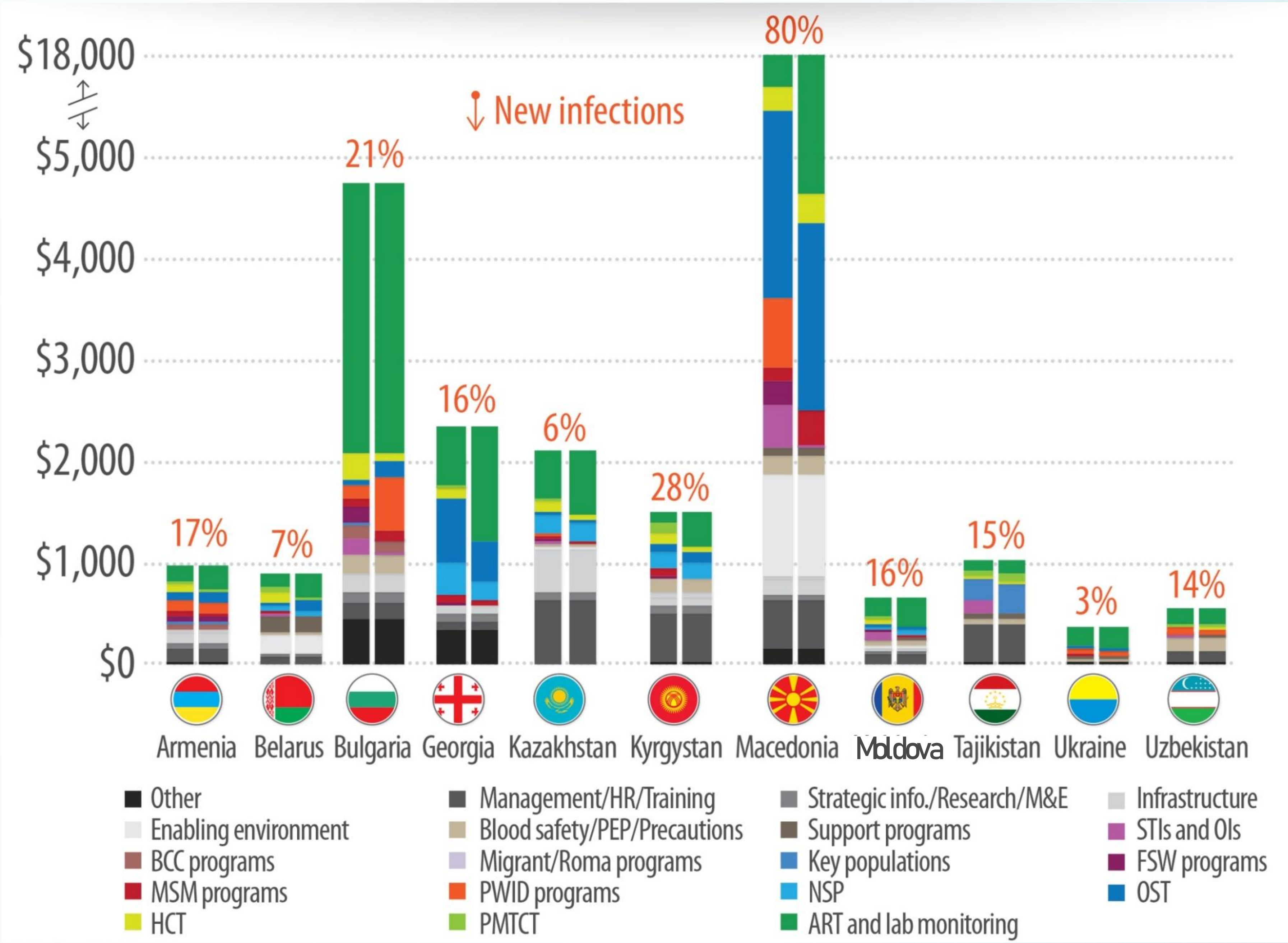
What is the optimized resource allocation to minimize HIV infections and HIV-related deaths by 2030 under varying funding levels?

Optimizing HIV investments in EECA



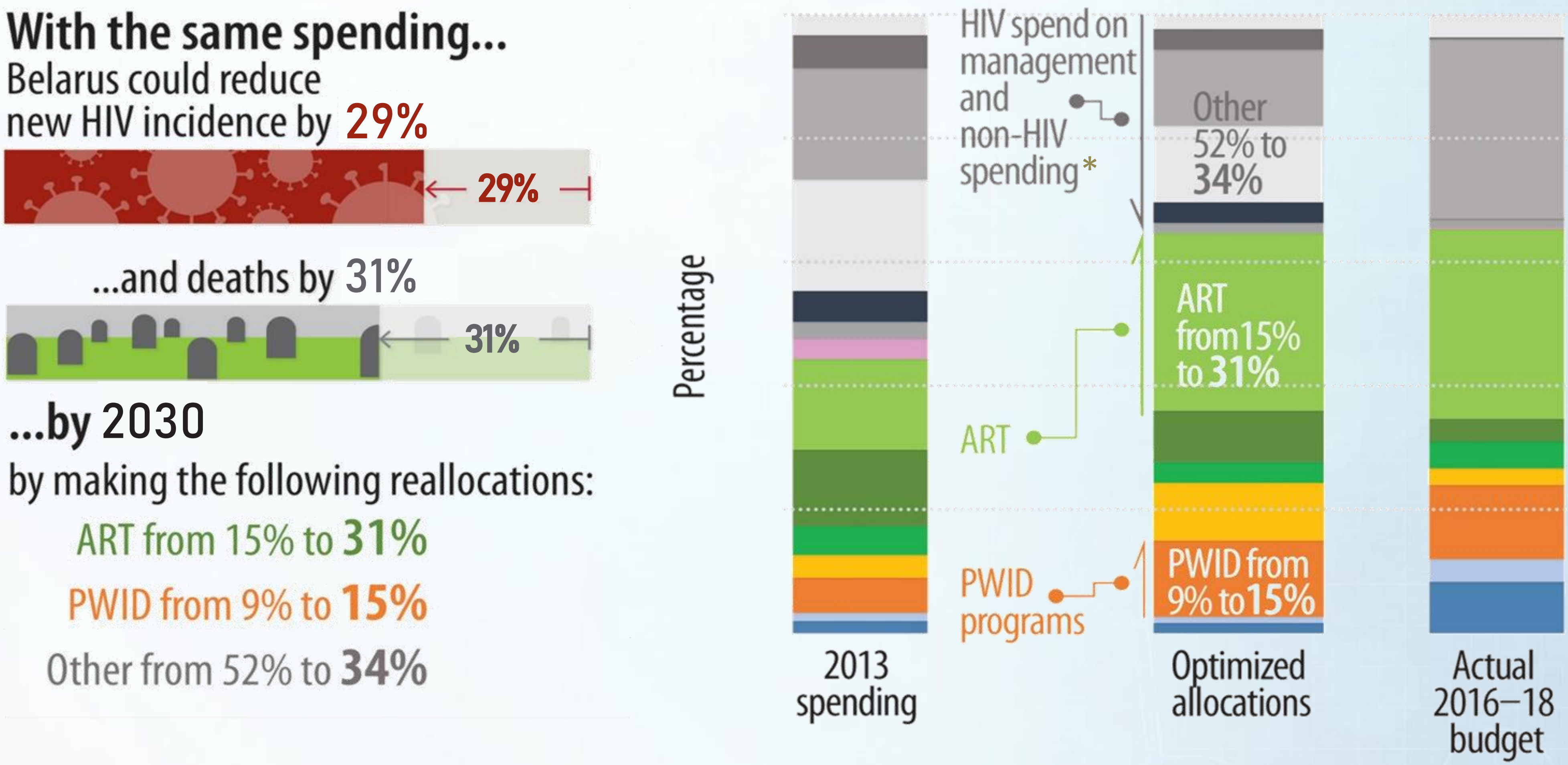
Optimization to minimize HIV infections and HIV-related deaths by 2020

Optimizing HIV investments in EECA per person living with HIV



Optimization to minimize HIV infections and HIV-related deaths by 2020

Optimizing HIV investments in Belarus

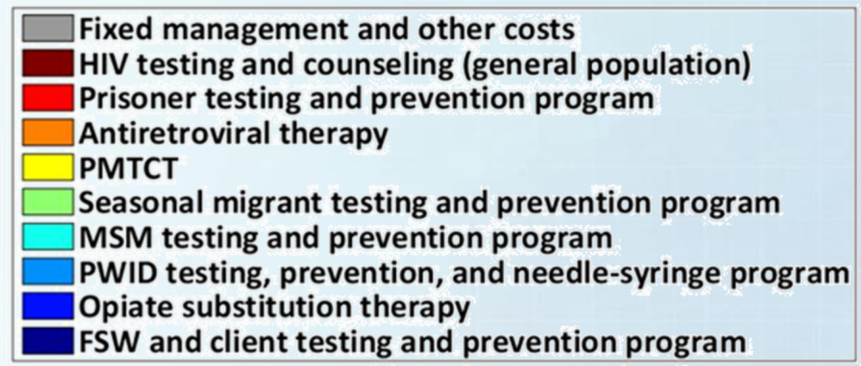


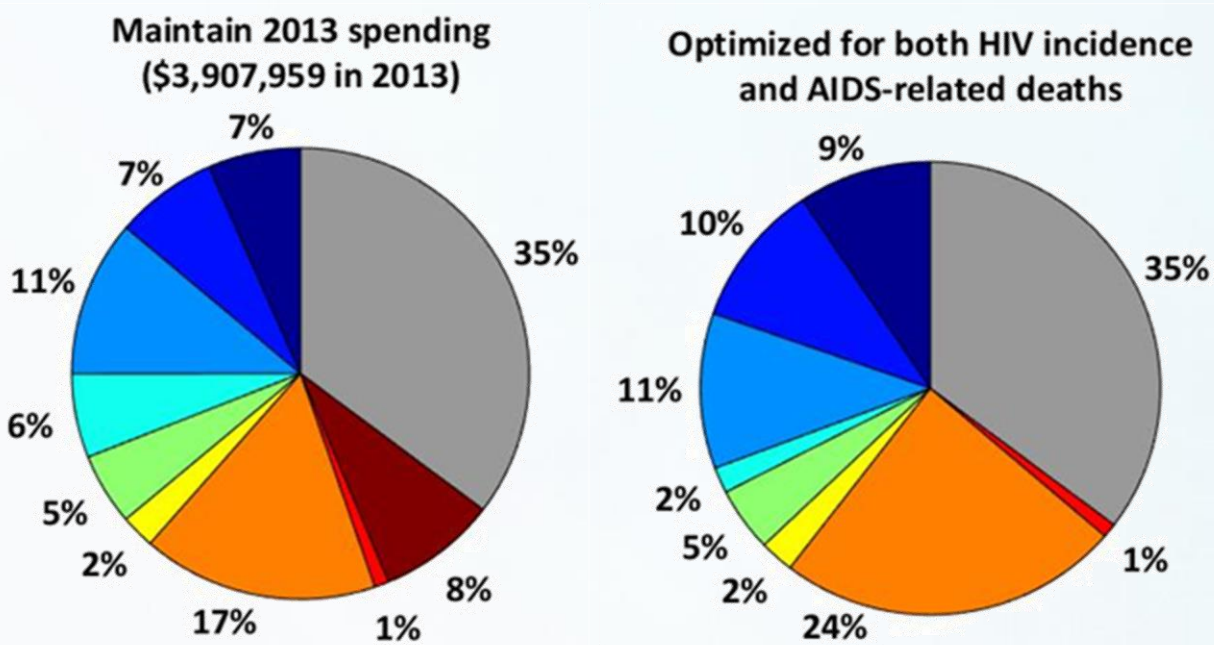
*non-targeted HIV program spending

Optimizing HIV investment in Armenia

Optimization of 2013 funding to minimize HIV infections and HIV-related deaths by 2020 -- recommend prioritizing:

- ART
- opiate substitution therapy (OST)
- testing and prevention programs targeting female sex workers (FSWs)
- Examine HIV programs targeting seasonal migrants, to determine program coverage effectiveness





Under optimized allocation, by 2020:

- 17% more new HIV infections
- 29% more HIV-related deaths

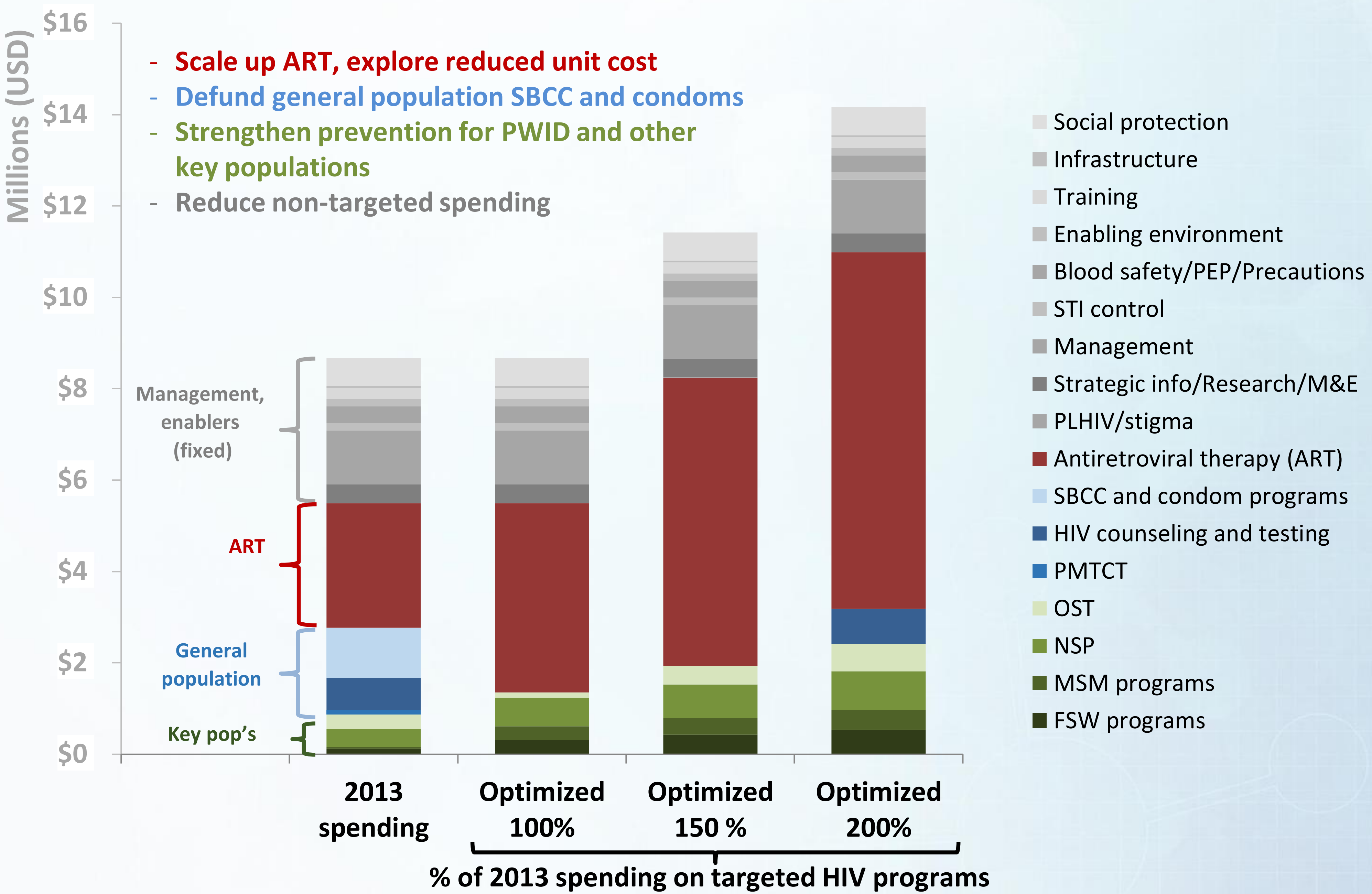
could be averted

Objective 3

What is the optimized HIV resource allocation for best achieving 90-90-90 by 2020 and 95-95-95 targets by 2030?

What are the minimum levels of resources required for best achieving these targets?

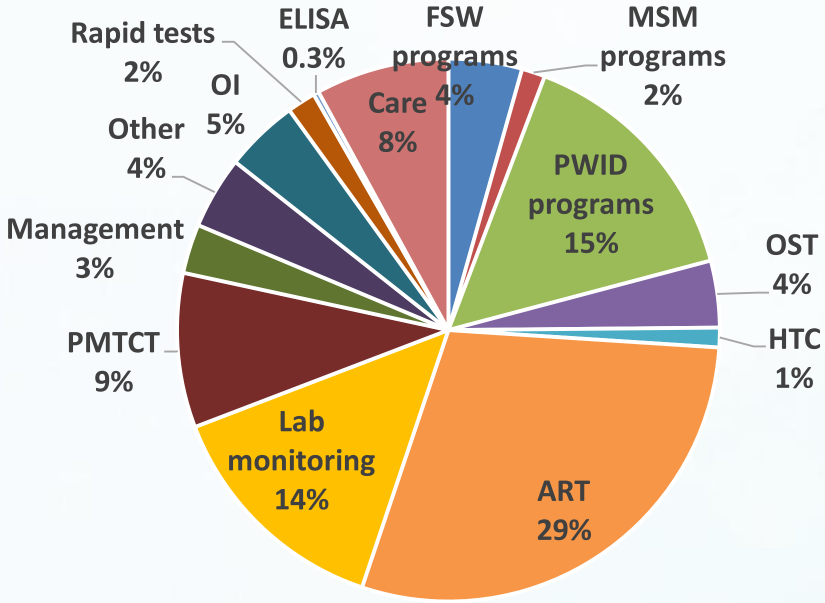
Varying HIV budget optimization in Moldova



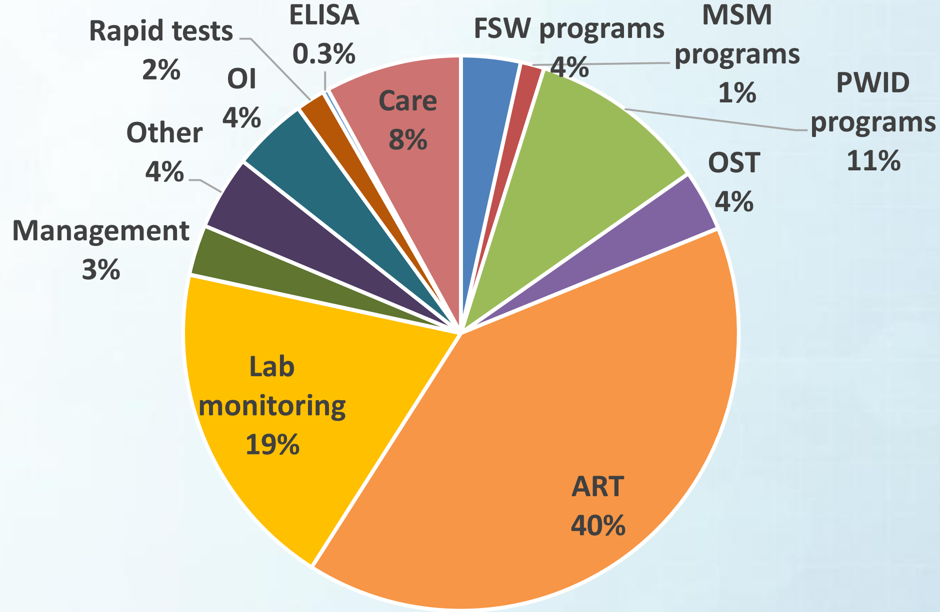
FSW: female sex worker. PMTCT: prevention of mother-to-child transmission. MSM: men who have sex with men. NSP: needle-syringe program. OST: opiate substitution therapy. SBCC: social and behavior change communication. STI: sexually transmitted infections.

Optimizing HIV investment in the Ukraine (1 of 4)

2013 budget allocations



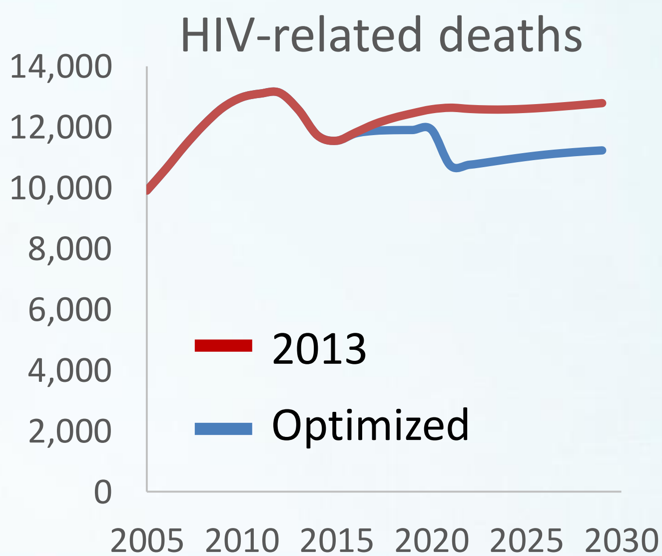
Optimized allocations of 2013 budget

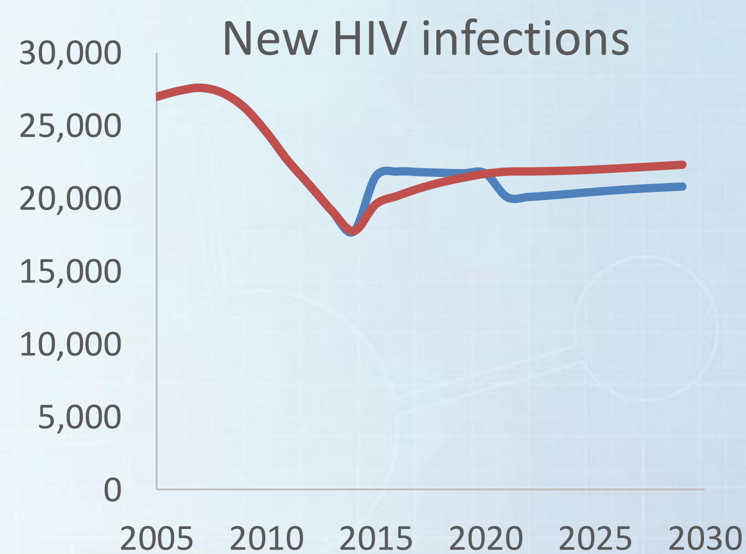


Under optimized allocation by 2020:

- 3% more new HIV infections
- 9% more HIV-related deaths

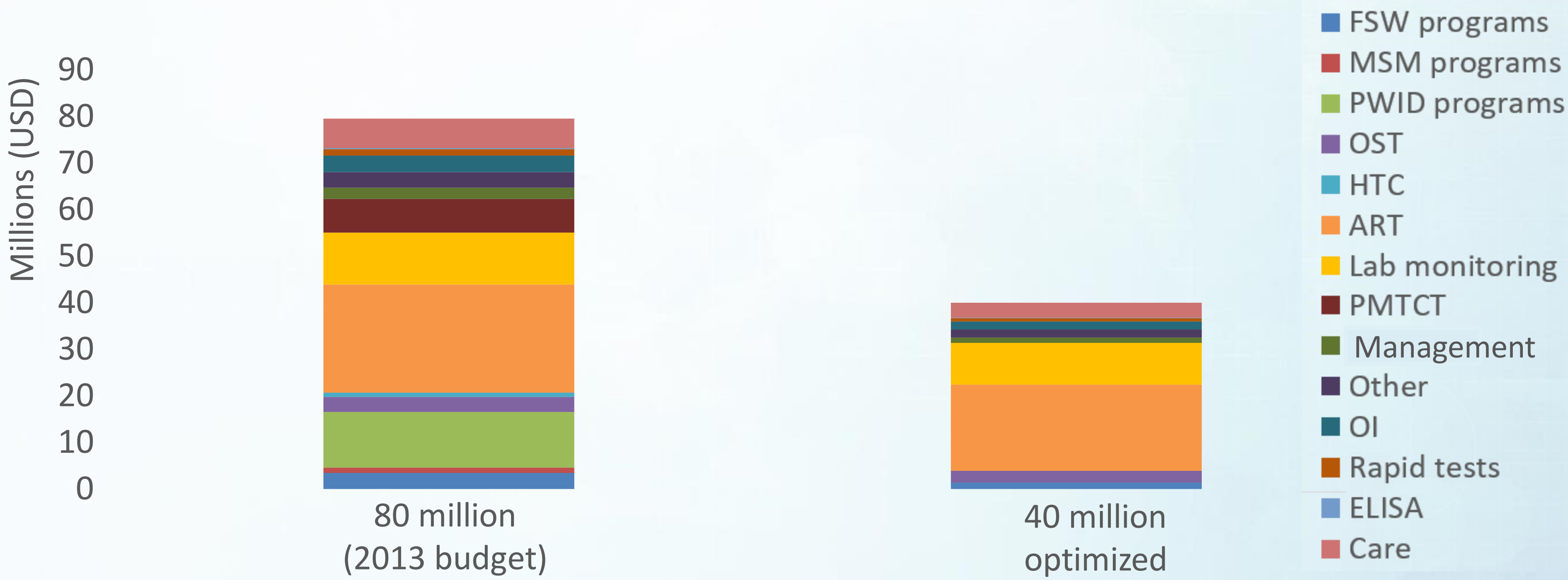
could be averted





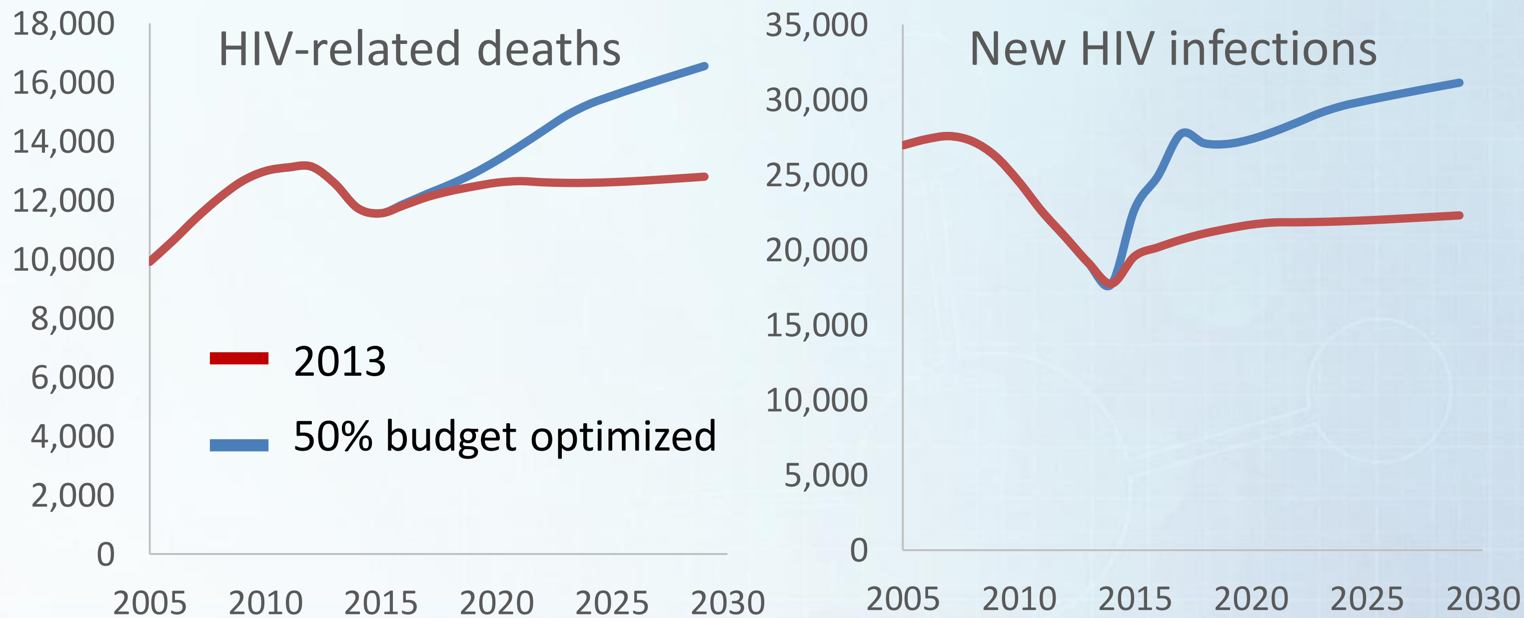
ELISA: enzyme-linked immunosorbent assay. OI: opportunistic infection.

Optimizing 50% HIV budget in the Ukraine (2 of 4)



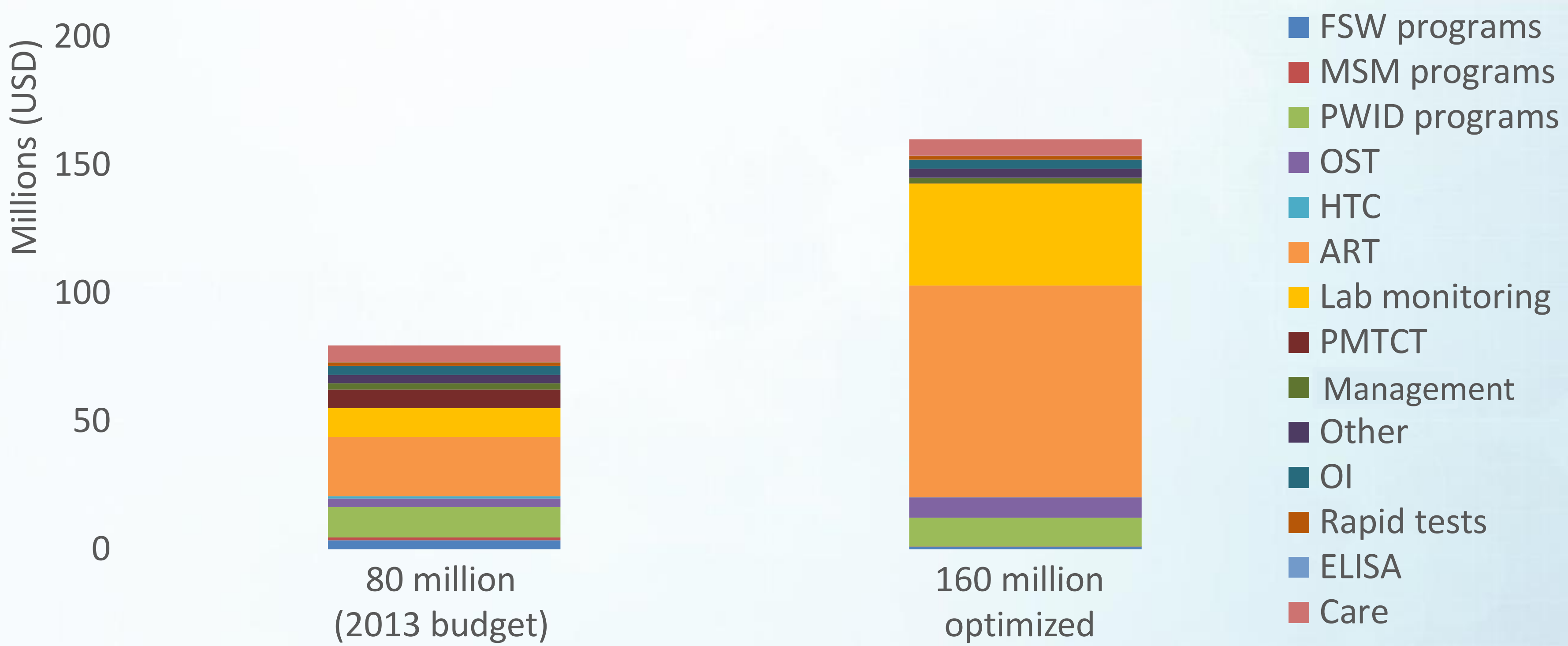
Even under optimized allocation of 50% budget by 2020 there could be:

- 36% more new HIV infections
- 14% more HIV-related deaths



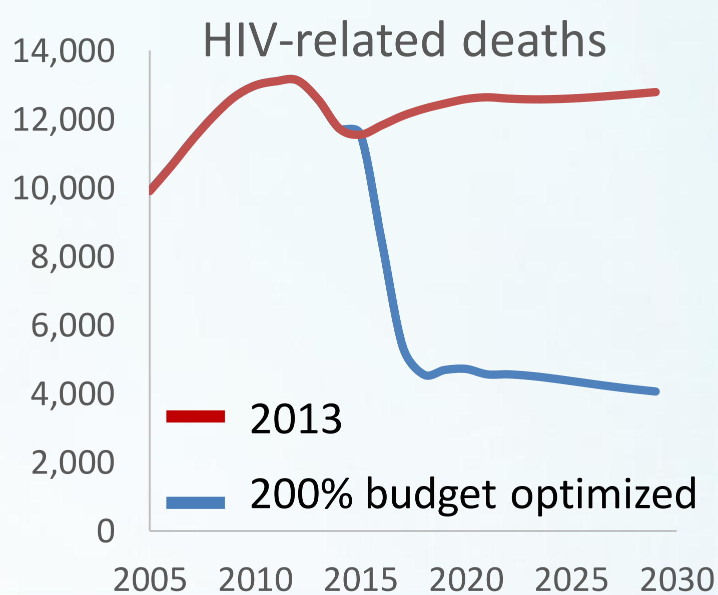
ELISA: enzyme-linked immunosorbent assay. OI: opportunistic infection.

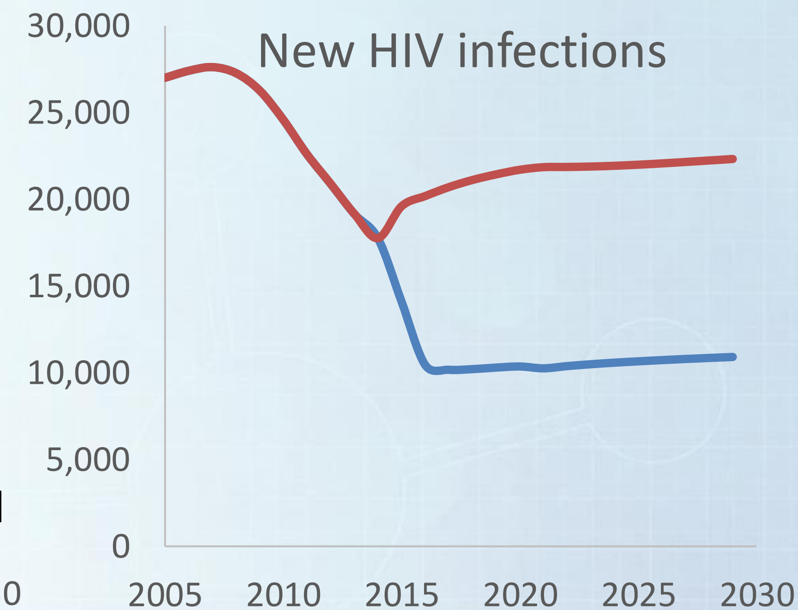
Optimizing 200% HIV budget in the Ukraine (3 of 4)



Under optimized allocation of 200% budget, by 2020 there could be:

- 48% more new HIV infections
- 61% more HIV-related deaths averted





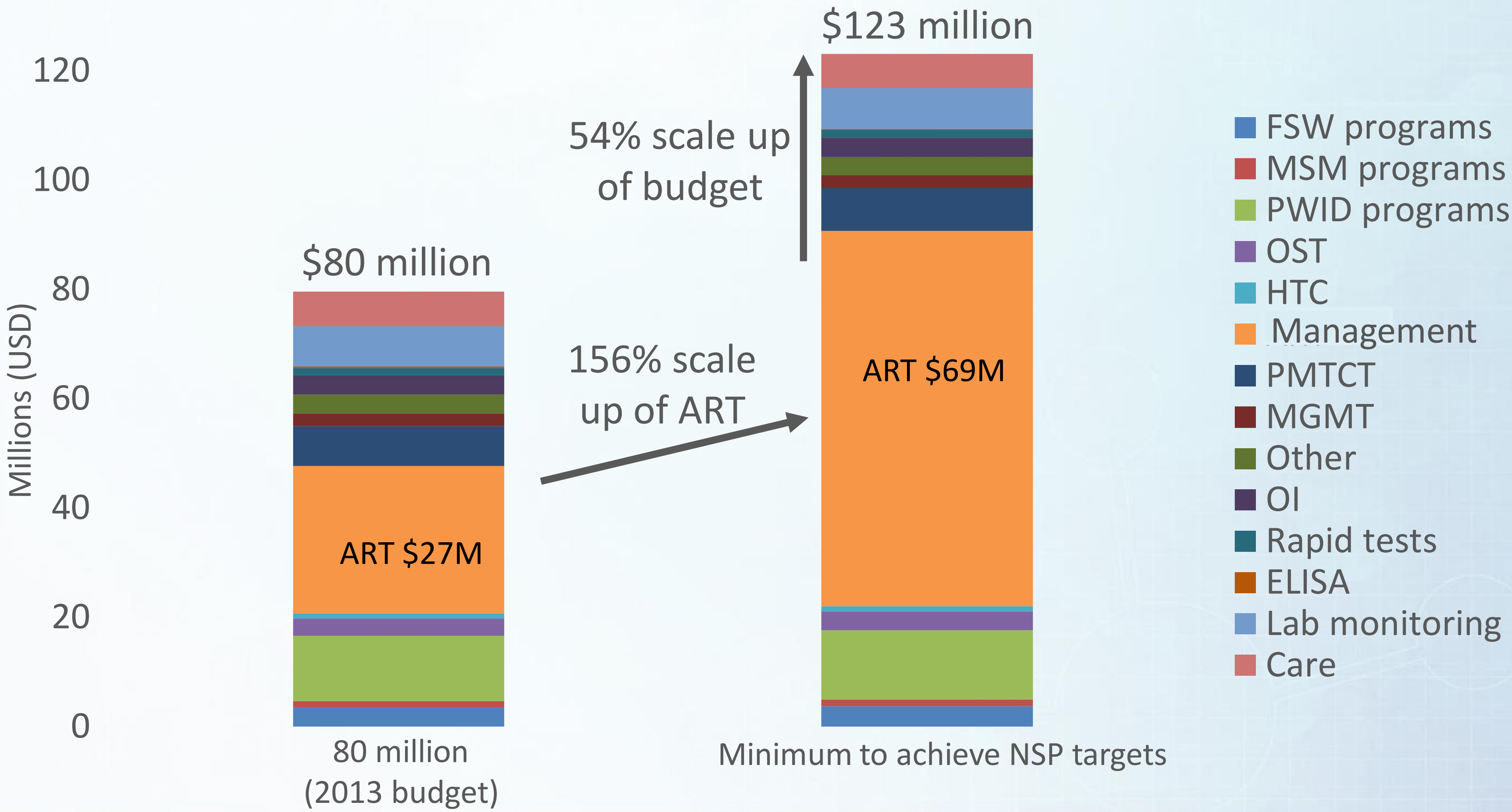
ELISA: enzyme-linked immunosorbent assay. OI: opportunistic infection.

Annual allocations to achieve 2018 national targets in Ukraine

NSP targets include, by 2018:

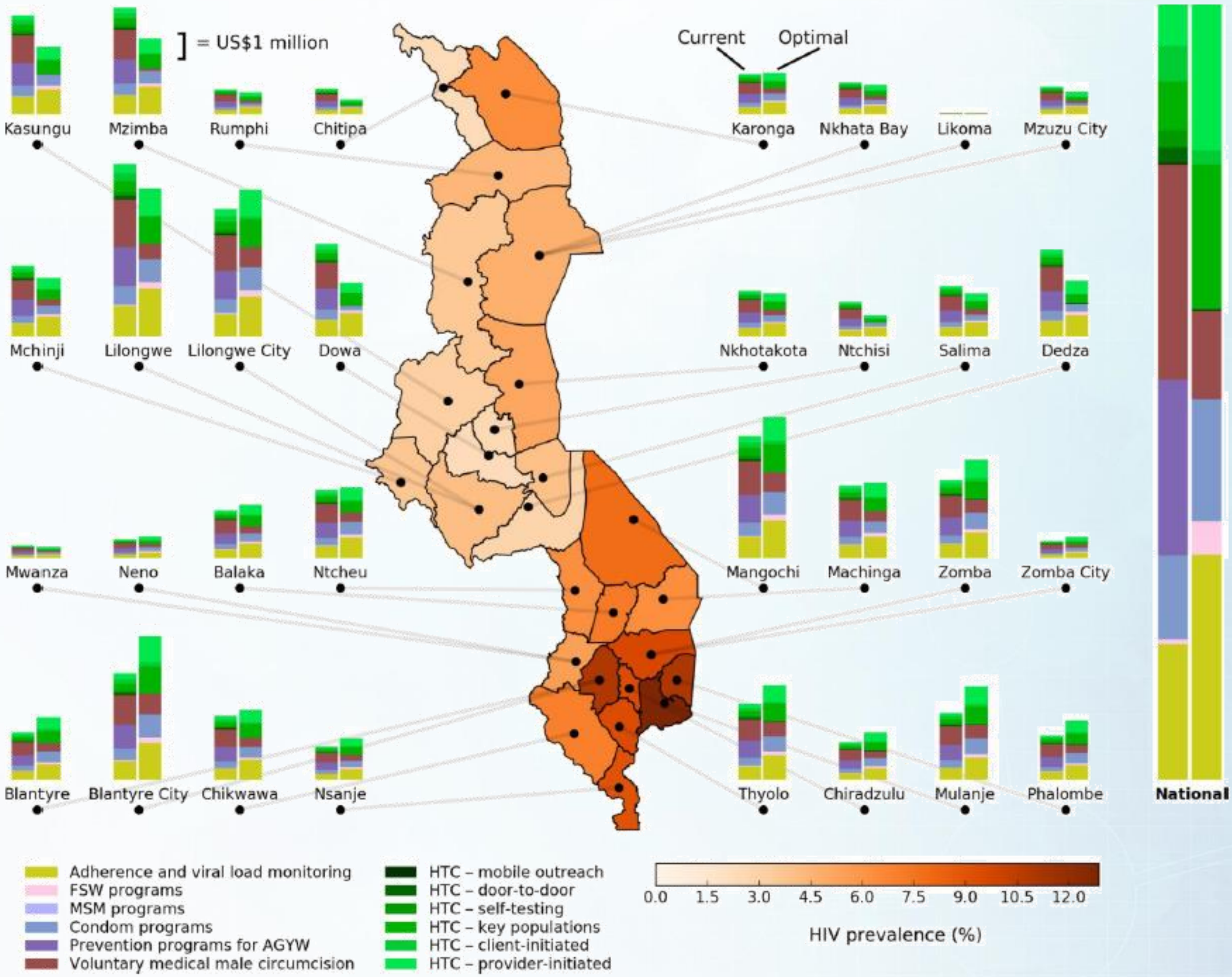
- 50% reduction in new HIV infections among key populations
- 50% reduction in TB-related HIV deaths

Operationalized in the model as a 50% reduction in both new HIV infections and HIV-related deaths (considering prevalence of TB) by 2018



ELISA: enzyme-linked immunosorbent assay. MGMT: management. OI: opportunistic infection.

Geographical optimization in Malawi



Creating an Optima HIV model project and completing the databook

Access to Optima HIV

Optima HIV tool is freely available online at:

hiv.optimamodel.com

Informing the Optima HIV model

- In the Optima HIV databook, collate these types of data and estimates:
  - demographic
    - population size: at last 2 annual values per population or an assumption
  - epidemiological
  - behavioural
  - programmatic

  Upload the databook to your Optima HIV project, within the tool

- To be entered in the Optima HIV project, within the tool, by HIV program:
  - costs
  - coverage
  - saturation

  Note: the ‘Cost & coverage” sheet inserted in the databook is used to store cost and coverage values, but they must be entered in the tool (they will not be uploaded with the databook)

Minimum data requirements for Optima HIV databook

Databook sheet	Indicators	Mandatory or optional
Populations	Populations by age, sex, risk	Mandatory
Population size	Population size estimates by population	Mandatory
HIV prevalence	HIV prevalence estimates by population	Mandatory
Other epidemiology	Background mortality, prevalence of STIs, and TB prevalence by population	Mandatory
Testing & treatment	HIV testing rates by population, probability of a person with CD4 <200 being tested per year, on ART, covered by ARV-based prophylaxis (PrEP, PEP) by population, on PMTCT, birth rate by female population, percentage of HIV-positive women who breastfeed	Mandatory
Optional indicators	Tests, diagnosis, modelled estimates (infections, prevalence, PLHIV, HIV-related deaths), initiating ART, PLHIV aware of status, diagnosed in care, in care on treatment (%), pregnant women on PMTCT (%), on ART with VS (%)	*Optional*
Cascade	Time to be linked to care by populations, time to be linked to care for people with CD4<200, lost to follow-up by population, people with CD4<200 lost to follow-up (%/year), VL monitoring, proportion of those with VL failure who are provided with effective adherence support or a successful new regimen, treatment failure rate	*Optional**
Sexual behavior	By population: number of acts by partner type (regular, casual, and commercial), condom use by partner type, and circumcisions by male population	Mandatory
Injecting behavior	Frequency of injection and needle-syringe sharing by population, number on opiate substitution therapy (OST)	Mandatory
Partnerships & transitions	Interactions for sexual and injecting partners, occurrence of births specified from which female population to youngest general population by sex where applicable, age- and risk-related movement between populations	Mandatory
Constants	Parameters (transmissibility, efficacy, disease progression, mortality, etc.)	Revise where context-specific values available

*Recommend to enter values for these two indicators at minimum within the cascade sheet:

(1) time take to be linked to care, if left blank everyone diagnosed will immediately be linked to care, and

(2) loss to follow up, if left blank no one would be lost to follow-up

if left blank will be **interpreted as zero** by the model, the model will run, but the outcome will not be realistic

Common data sources

For demographic, epidemiological, and behavioural values:

- UNAIDS Global AIDS Monitoring (GAM) report
- Integrated Bio-behavioural Surveillance (IBBS) report
- Demographic and Health Survey (DHS)
- Annual Monitoring & Evaluation (M&E) progress report
- Multiple Indicator Cluster Survey (MICS)

'Optional indicators' sheet in the databook, to be completed using:

- estimates from Spectrum or other models

Used for comparison in the calibration, not to inform the model

Consult the **Optima HIV User Guide Vol. IV - Indicator Guide**
http://optimamodel.com/indicator-guide

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Choose a demonstration project from our database:

Concentrated (demo) ▼ | Add this project

Or create/upload a new project:

Create new project | Upload project from file | Upload project from spreadsheet

☐	Children	Children	Edit	Copy
☐	Infants	Infants	Edit	Copy
☐	Other males	Males	Edit	Copy
☑	Other females	Females	Edit	Copy
☐	Other males [enter age]	Other males	Edit	Copy
☐	Other females [enter age]	Other females	Edit	Copy

Add population

Create project & download data entry spreadsheet

Completing the Optima HIV databook

Demographic, epidemiological, and behavioral values to be entered in an Excel spreadsheet – the databook

- for the total population or by population group*,
- by year or as an assumption value, and
- for certain indicators, for the best value, as well as low and high bound values (bound values are optional)

HIV prevalence		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		Assumption
FSW	high	5.00%					7.00%				5.00%					7.00%			8.00%		OR	
FSW	best	3.50%					4.40%				3.50%					4.40%			5.00%		OR	
FSW	low	2.00%					3.00%				2.00%					3.00%			4.00%		OR	
Clients	high																				OR	
Clients	best												0.80%								OR	
Clients	low																				OR	
MSM	high												8.00%								OR	
MSM	best				2.16%		2.65%			3.62%			4.73%						3.62%		OR	
MSM	low												2.00%								OR	

*Key population size values must be subtracted from the general population values by sex, and age where applicable, to ensure that the sum of the total population is representative

Entering data in the Optima HIV databook – only in designated areas of the databook

In the databook note the following:

- Do not alter values in columns A (indicator), B (population names), X (“OR”) or Y (Assumption)
- Extra rows may be added, but do not move existing text and cells shaded in blue
- New sheets can be added for additional data or calculations

Do not alter these rows (or enter any text). Do not alter indicator, year and assumption labels

HIV prevalence																							
			2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**		**Assumption**
	FSW	high	5.00%					7.00%				5.00%					7.00%			8.00%		**OR**	
	FSW	best	3.50%					4.40%				3.50%					4.40%			5.00%		**OR**	
	FSW	low	2.00%					3.00%				2.00%					3.00%			4.00%		**OR**	
	Clients	high																				**OR**	
	Clients	best												0.80%								**OR**	
	Clients	low																				**OR**	
	MSM	high												8.00%								**OR**	
	MSM	best				2.16%		2.65%			3.62%			4.73%						3.62%		**OR**	
	MSM	low												2.00%								**OR**	

Partnerships & transitions

Partnerships: Enter values in rows for males, representing partnership ratio

Interactions between casual partners	FSW	Clients	MSM	PWID	Males 0-14	Females 0-14	Males 15-49	Females 15-49	Males 50+	Females 50+	Prisoners
Clients								5		1	
MSM			1								
PWID				5				4		1	
Males 0-14											
Males 15-49								5		1	
Males 50+								1		5	
Prisoners											1

Risk transitions

- Average number of years those at risk spend in that risk group before transitioning back to respective general population groups
- If only 1 risk population transitions to general population, enter average number of years before transition, e.g., 10 years for clients transitioning to males 15-49 years
- Risk population transitioning to >1 general population group, e.g., for FSW

Risk-related population transitions (average number of years before movement)	Males 20-24	Females 20-24	Males 25-49	Females 25-49	Males 50+	Females 50+		Average
FSW		60		20				15
Clients	50		17		50			10

... Testing & treatment | Optional indicators | Cascade | Sexual behavior | Injecting behavior | Partnerships & transitions | Constants

use this simple calculation

$$\frac{1}{(1/60 + 1/20)} = 15 \text{ years on average}$$

Considerations: data availability (or lack thereof)

- **Population size** for certain key populations may be difficult to estimate where not reported
  - **Assumptions** may be needed, e.g., assume client population size 3-times the population size for FSW
- Limited data on sexual and injecting behaviour
  - Integrated Bio-behavioural Surveillance (IBBS) reports are a possible source
- Variation in data reliability and completeness must be assessed and handled with modelling team on a case-by-case basis

Considerations

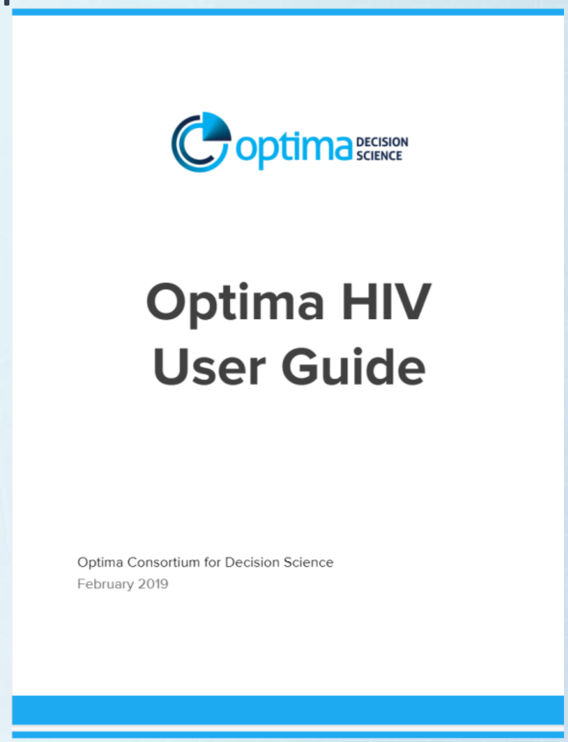
- Resolving data inconsistencies
  - Ensure sum of population size values = total national population
  - For example, resolve discrepancies in number of sexual acts reported by men and by women who are sexual partners
- Data, estimates, and assumptions used to inform the model must be carefully reviewed by the country team together with the modelling team

Support for Optima users on data entry

- User **training**, including practical exercises
- Optima HIV User Guide: **optimamodel.com/user-guide**
  - **Volume IV: Indicator Guide**: guidance on how to fill in the Optima HIV databook
  - **Volume V: Expenditure Data Guide** guidance on how to prepare cost, coverage and expenditure data for use in Optima HIV analyses, including NASA sources
- Data spreadsheets undergo several **reviews** by Optima HIV team together with country team

- Optima **team** provides support

info@ocds.co



Model calibration

What is model calibration?

- **Calibration:** is the process of adjusting model parameters to get the best possible match to all available data and estimates
- *Ideally*
  - The model structure would perfectly reflect the real-world status of HIV
  - All values would be consistently reliable and complete
  - Uncertainties and biases would be minimal
- *In practice*
  - Population-based models make simplifying assumptions that are most likely not representative (e.g., population homogeneity)
  - Values (especially historical) may have inconsistencies, bias (e.g., sampling), and gaps

Sources for calibration

- All data and estimates entered in the databook can be used to calibrate the model

- In practice, the most reliable and key values for calibration are, in order of importance:
  - Annual numbers of people on treatment
  - Prevalence estimates
  - Other cascade values (proportion diagnosed, proportion virally suppressed, etc.)
  - Values in 'Optional indicators' sheet: estimates of new HIV infections, HIV-related deaths, etc. (typically from Spectrum or other models)
    - These are only used to guide the calibration, they are <u>not</u> used to inform the Optima HIV model

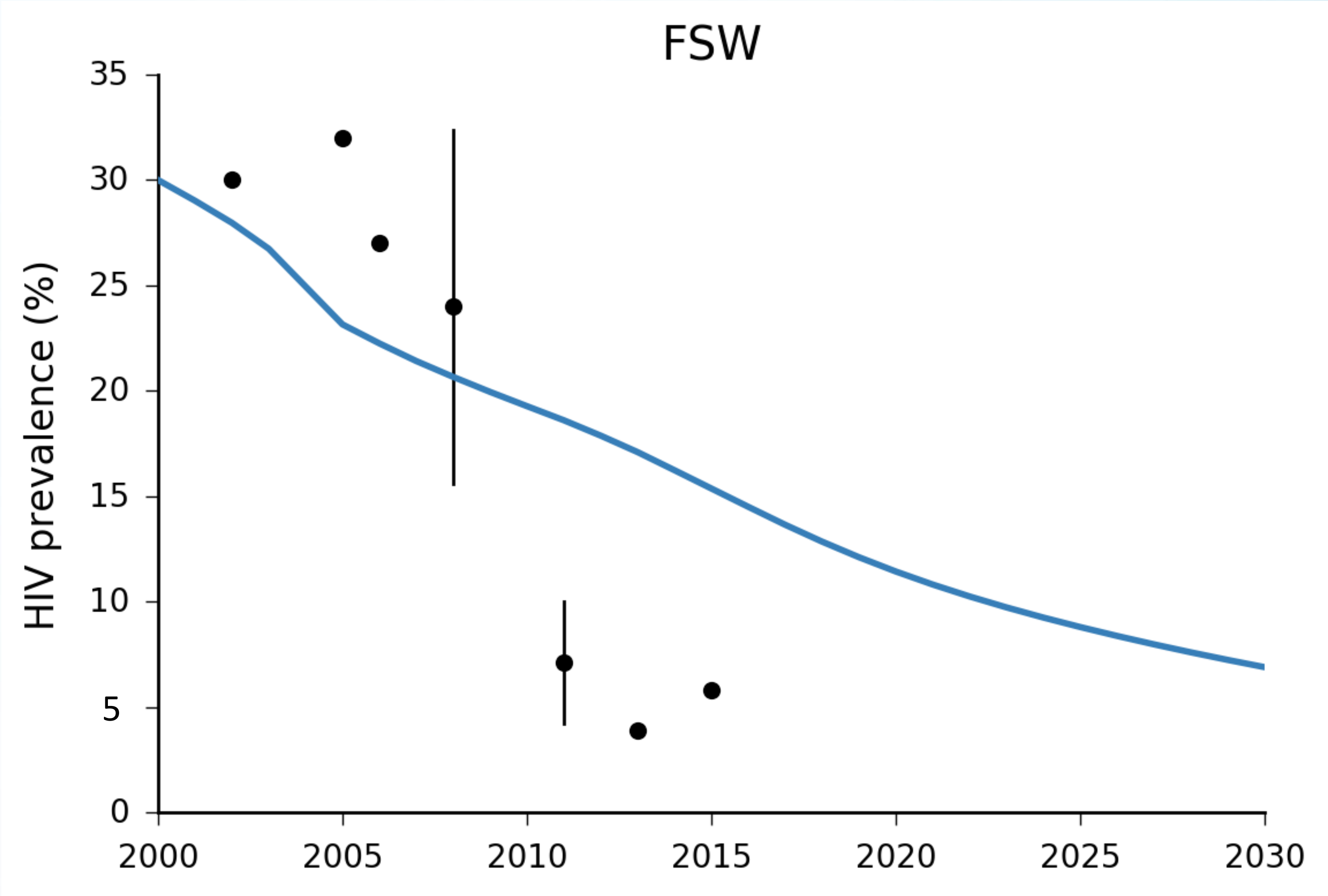
Data consistency

- Examine trends over time
- Examine all data sources to identify the most reliable source(s) and value(s)
- Consider values across populations who are sexual partners, eg, sexual behaviours (commercial acts, condom use) between FSW and their clients. Are they balanced?
- Consider how values contributed to the status of HIV in a given setting. For example, by population and year:
  - HIV prevalence x population size = estimate people living with HIV

  Does this seem reasonable?

Does this trend seem reasonable?

- Estimates from different sources may not be consistent
- Methodologies, sites, etc., can change from year to year
- **Does this decrease seem realistic?**



How to calibrate in Optima HIV

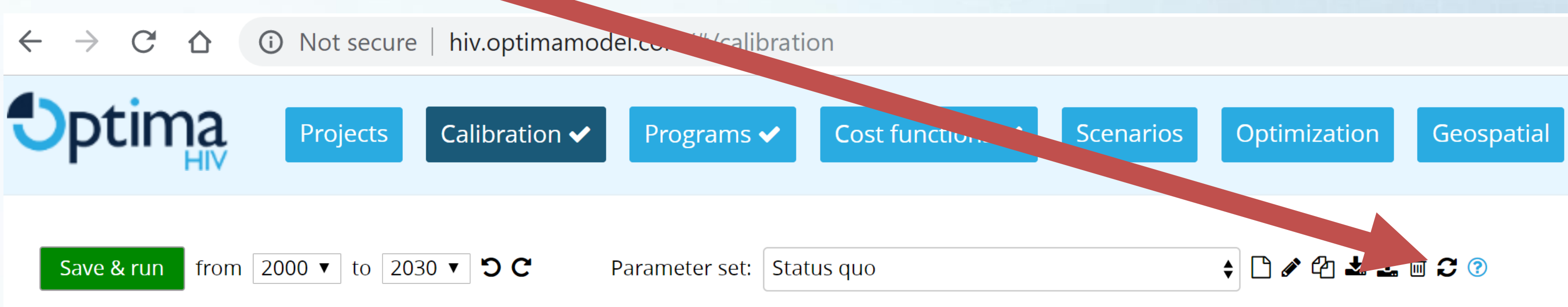
1. Run an **auto**-calibration (unlimited time)
2. Adjust using **manual** calibration as necessary

   Most common parameters to adjust, by population group:

   - Initial HIV prevalence
   - Force of infection (unitless, guide: <10 to >0.01)

   Other parameters [also select 'Advanced options' button]

   - Death rate, treatment failure rate, testing rate (meta), # VL tests pp/year
   - Inhomogeneity (how much curve "bends" or changes over time) (unitless)
   - Year to fix (proportion of) PLHIV aware of their status, care, treatment, VS (if programs influencing, latest year, e.g., 2018): 2100
3. Re-upload the databook, hit refresh



Calibration is an iterative process to fit the model to the HIV status

Additional notes for calibration

- First fit to:
  - Population size by population: adjust birth/death rates
  - Treatment: model will automatically fit
  - New HIV diagnoses
  - HIV prevalence by population
  - Infections – deaths – people living with HIV

  Then, iterate. Re-adjust. Save parameter sets.

- When **calibrating** the model, you have the option to pay *more attention to some value points than others*
- Optima will **automatically fill-in certain gaps**
  - e.g. population sizes: interpolates missing values between entered annual values and projects to the project end year

HIV programs cost and coverage data

Impact of HIV programs

To model the impact of HIV programs on the status of HIV using **cost functions**, represent the relationship between:

- program **spending** and program **coverage**
- program **coverage** and **outcome**

Overview of HIV programs

- Optima HIV can accommodate programs that:
  - Targeted programs: direct impact
    - i.e., diagnostic, treatment, prevention, behavioral, awareness campaigns
  - Non-targeted programs: indirect impact, included in the budget, not considered in the optimization
    - i.e. management, infrastructure, M&E, enabling environment, etc.

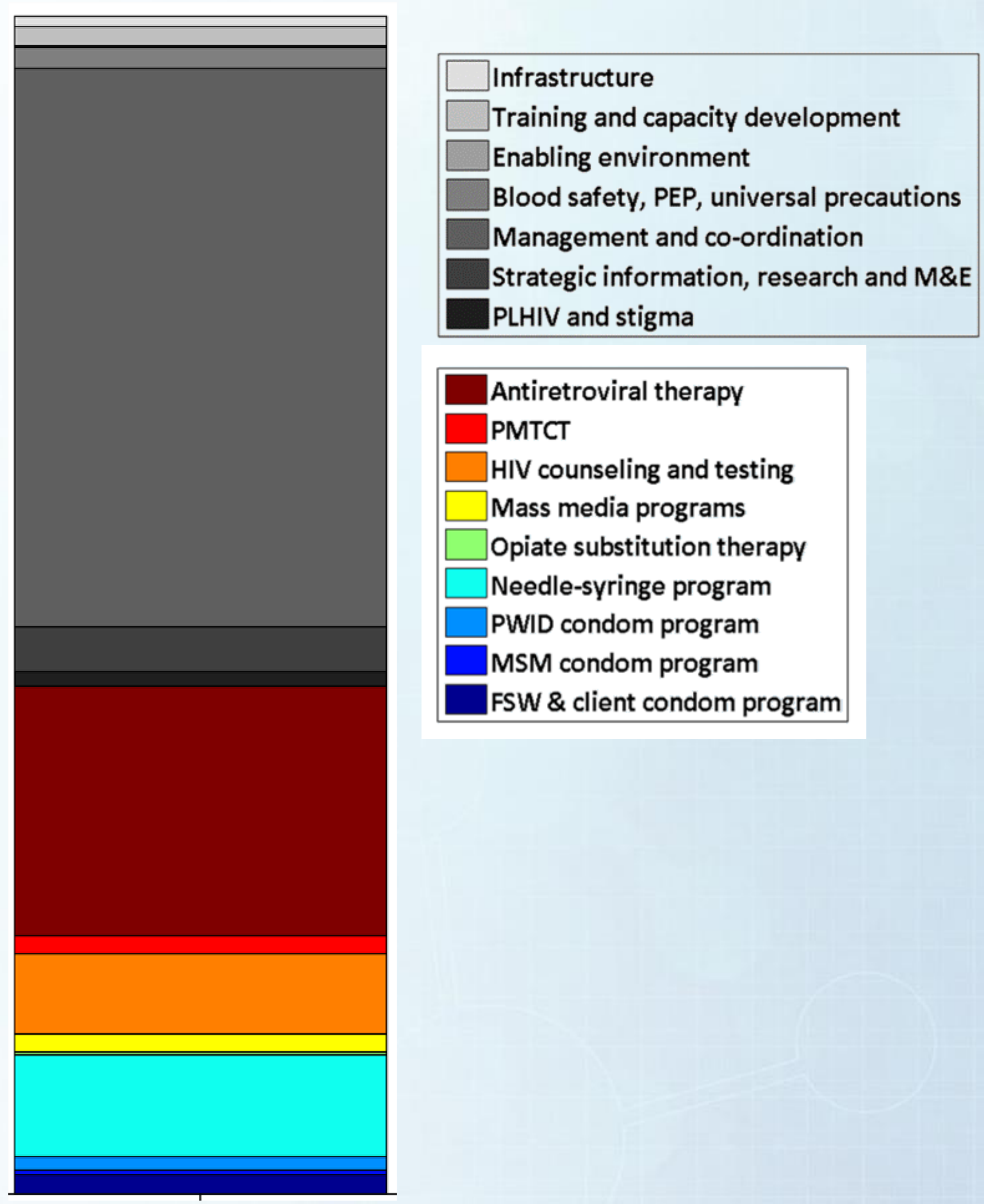
- Each targeted HIV program including in the model requires at least two of the three for:
  - Spending
  - Coverage (number of people reached)
  - Unit cost

  As well as:
  - Saturation
  - Impact on disease (efficacy) – *model global defaults can be used*

- Program component can include programs not currently implemented, but may be planned for roll-out in the future
- There may be >1 service delivery modalities for each type of program or intervention (e.g. self-testing, mobile testing etc.). These are handled as separate programs in the Optima HIV model.

HIV program spending

- Can be reported directly (top-down costing)
- Alternatively, can be reconstructed from unit costs and program coverage (bottom-up costing)



Cost definitions

Unit cost

- Total program cost divided by the number of people covered
- Total cost/number of people covered
- E.g. $100/10 = $10

Marginal cost

- Cost of covering one more person

Variable unit costs

- Relationships between costs and coverage are generally **nonlinear**, because costs change depending on the level at which the program is operating
- Optima allows users to specify programs with costs that vary depending on coverage
- We expect **increasing marginal costs** as programs **expand coverage** to increasingly hard to reach populations (saturation)

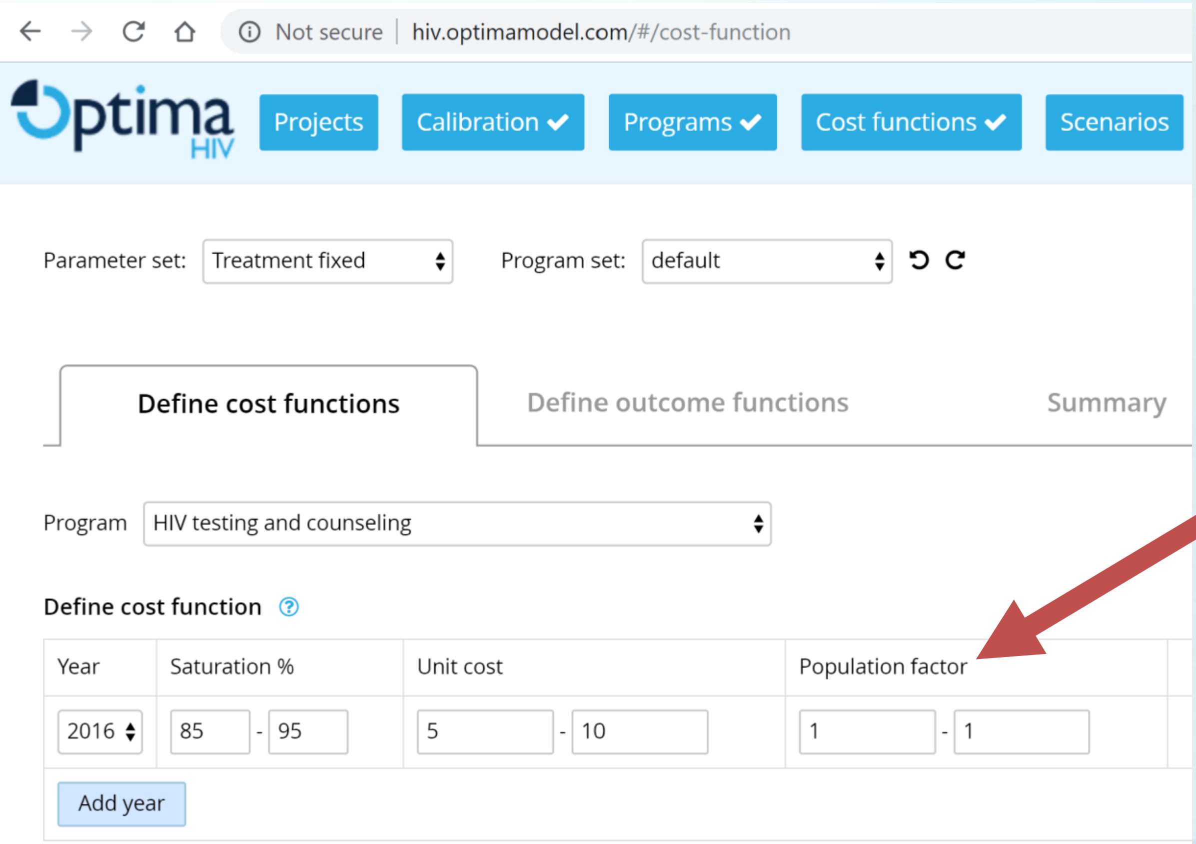
Population factor

- This factor is to account for the:

  proportion of the population *actually* being targeted by model parameters (that is for whom the model parameter is relevant)

  – Generally: 1-1

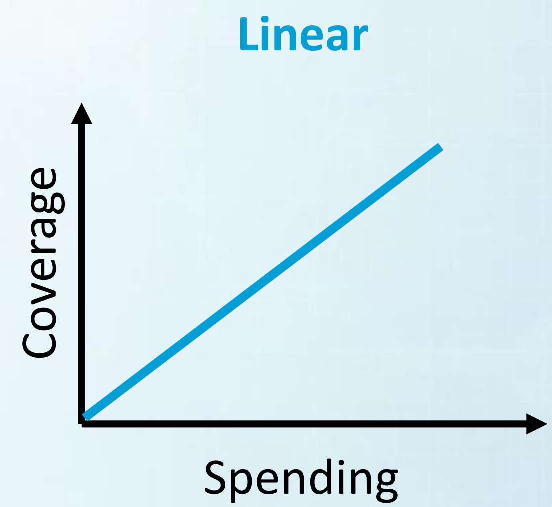
  – Program service delivery modalities, e.g. for mobile clinic testing service modality, may have a population factor <1 (as a range)

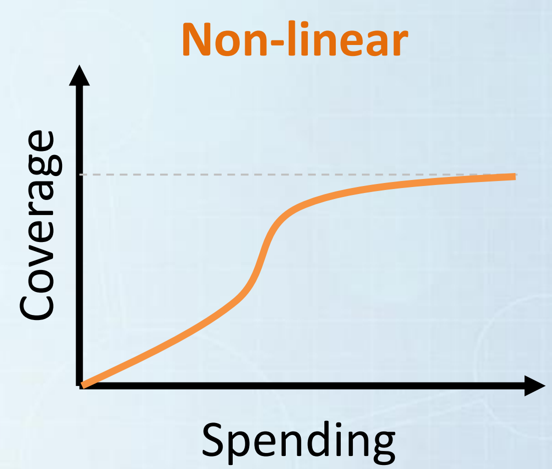


Relating program costs and population coverage

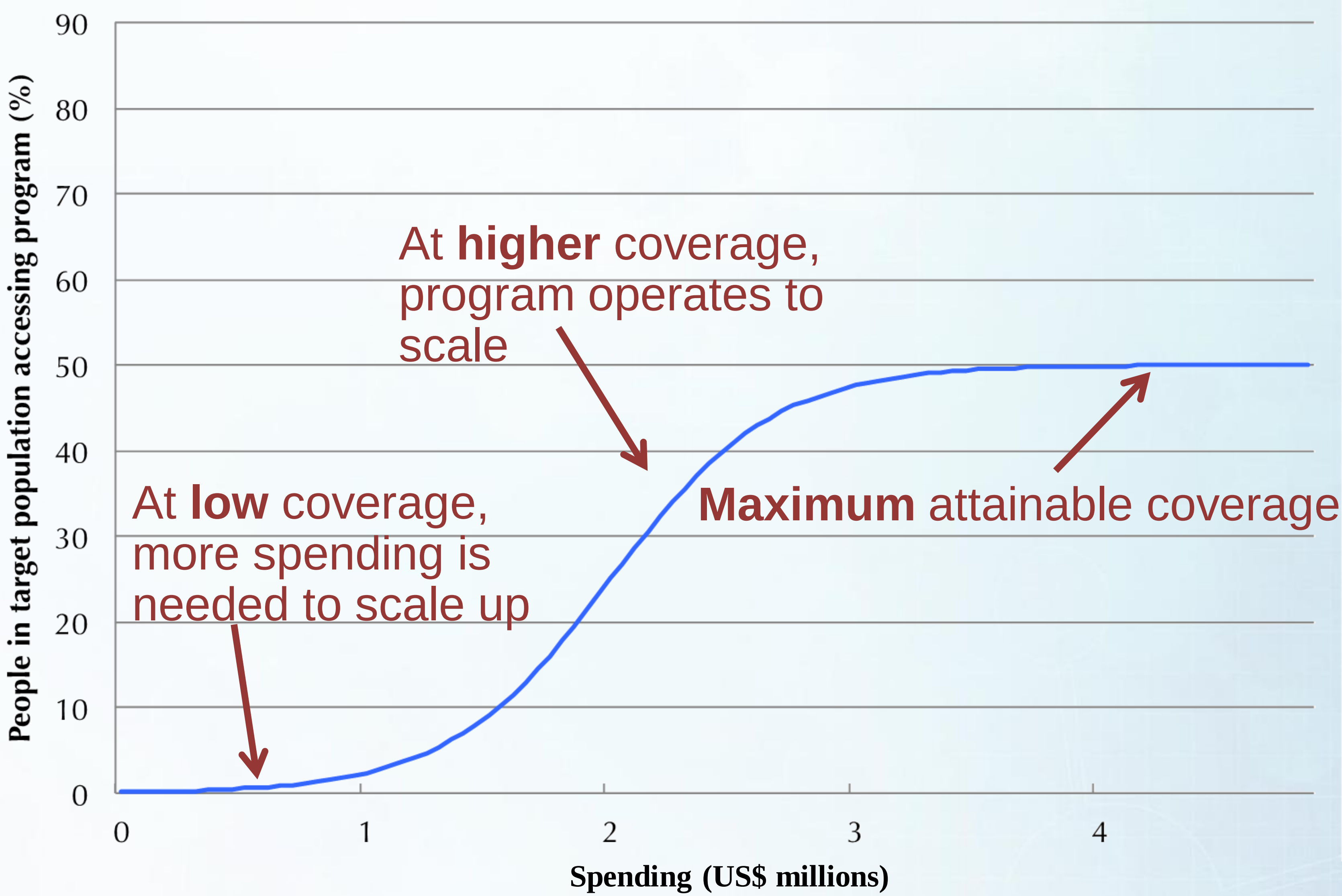
Cost-coverage curves:

- Relates program spending to program coverage
- Cost-coverage curves can be
  - **Linear**: slope represents a single unit cost, or
  - **Non-linear**: slope represent scale-up, stable implementation, and increasing effort in reaching additional people
- In the absence of estimates, **linear** cost-coverage curves are assumed





Cost functions: cost-coverage curve



Cost functions: requirements and data sources

Data requirements

1. Cost: total spending and unit costs

Data sources

- National AIDS Spending Assessment (NASA)
- Global Fund, PEPFAR expenditures, etc.
- Country programme reports
- Other (e.g. Global Health Costing Consortium Unit Cost Repository)

2. Coverage: number of people reached

3. Outcomes under:

- Zero spending ($0): in the absence of any programs targeting this parameter
- Outcome under maximum attainable coverage (under unlimited spending): for each program acting in isolation (recommend using additive interactions)

Data sources

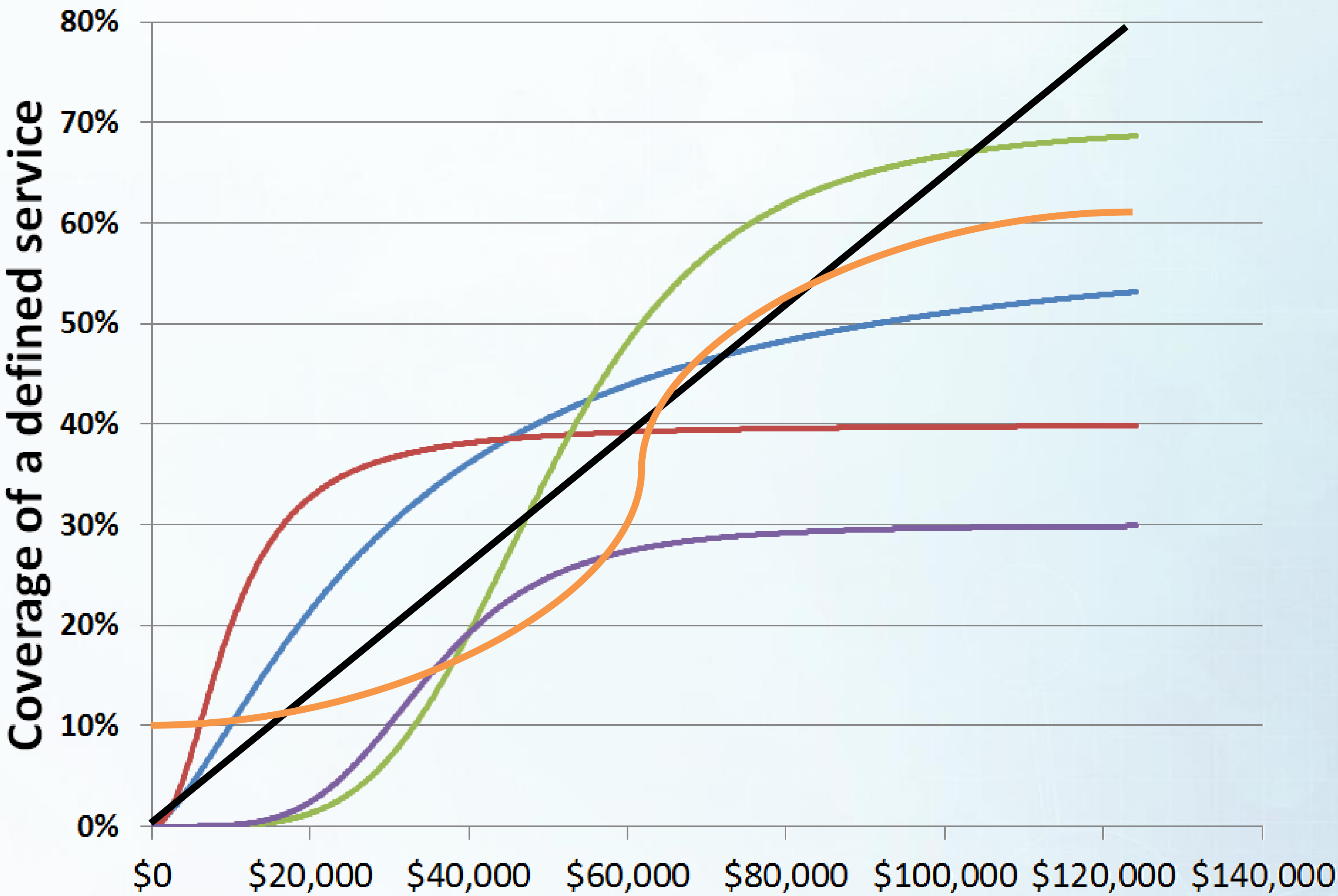
- Global AIDS Monitoring (GAM) reports
- Annual program and M&E reports

Cost-coverage and coverage-outcome relationships

For each program (representing an intervention modality):

- Define cost-coverage and coverage-outcome relationships
  - **Coverage** is % of population reached (or number of people)
  - **Outcome** described as relationship representing the:
  - "Change in outcome per person" for
  - "Change in coverage per person"
    - e.g., for every person reached by a testing program, their chance of being tested is x%
- Link spending to outcomes
  - [$0, $1, …, $N] -> [Out0, Out1, …, OutN]
- For allocative efficiency assessment, ideally want a single outcome: [$0, $1, …, $N] -> OutX

Cost functions for each HIV program or modality

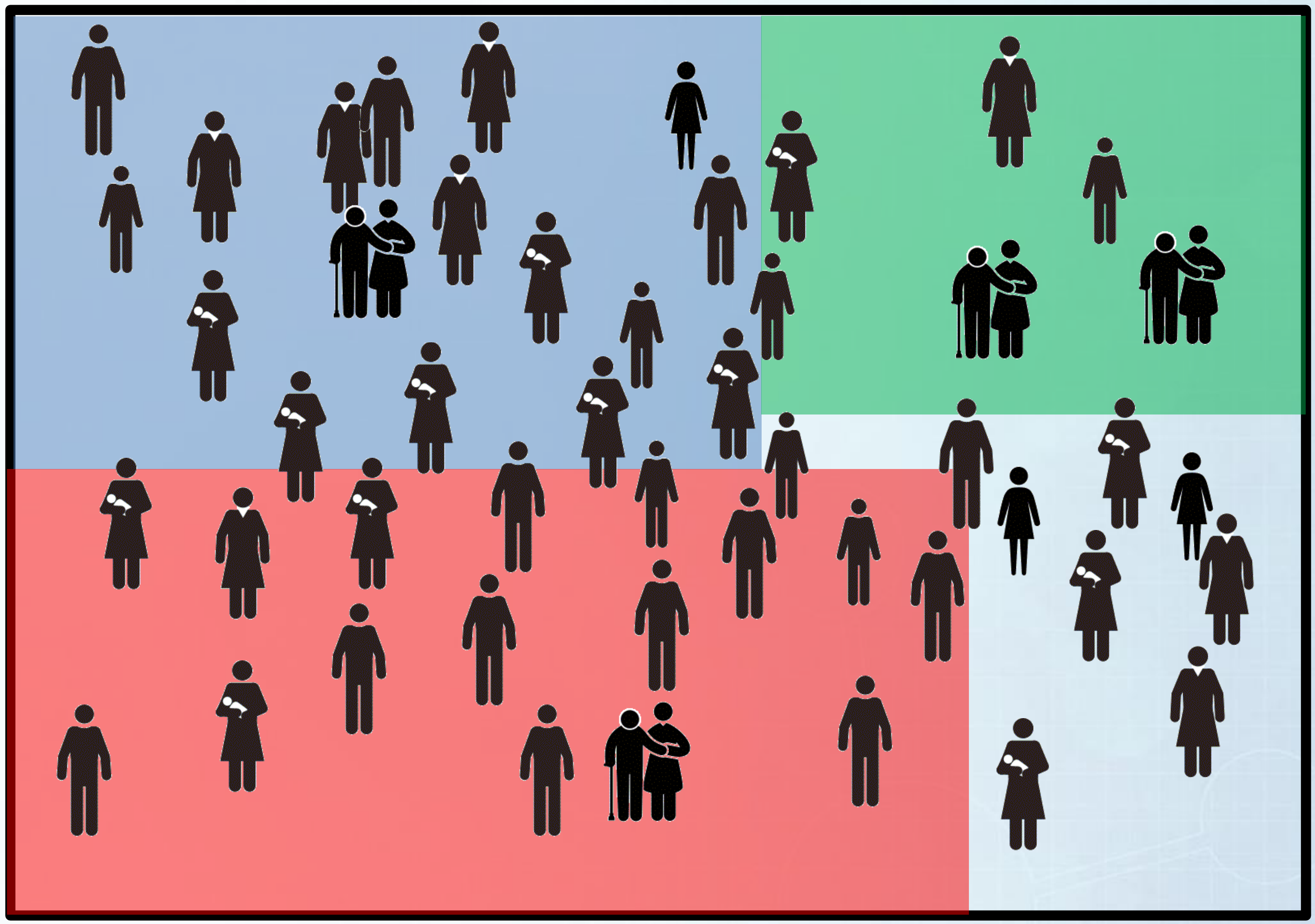


Each program or service modality has it's own **cost-outcome** curve

For every parameter, the type of program interaction is set

Option 1: **additive** (optional - recommended)

Entire target population



Coverage reached by program X for $\$_X$

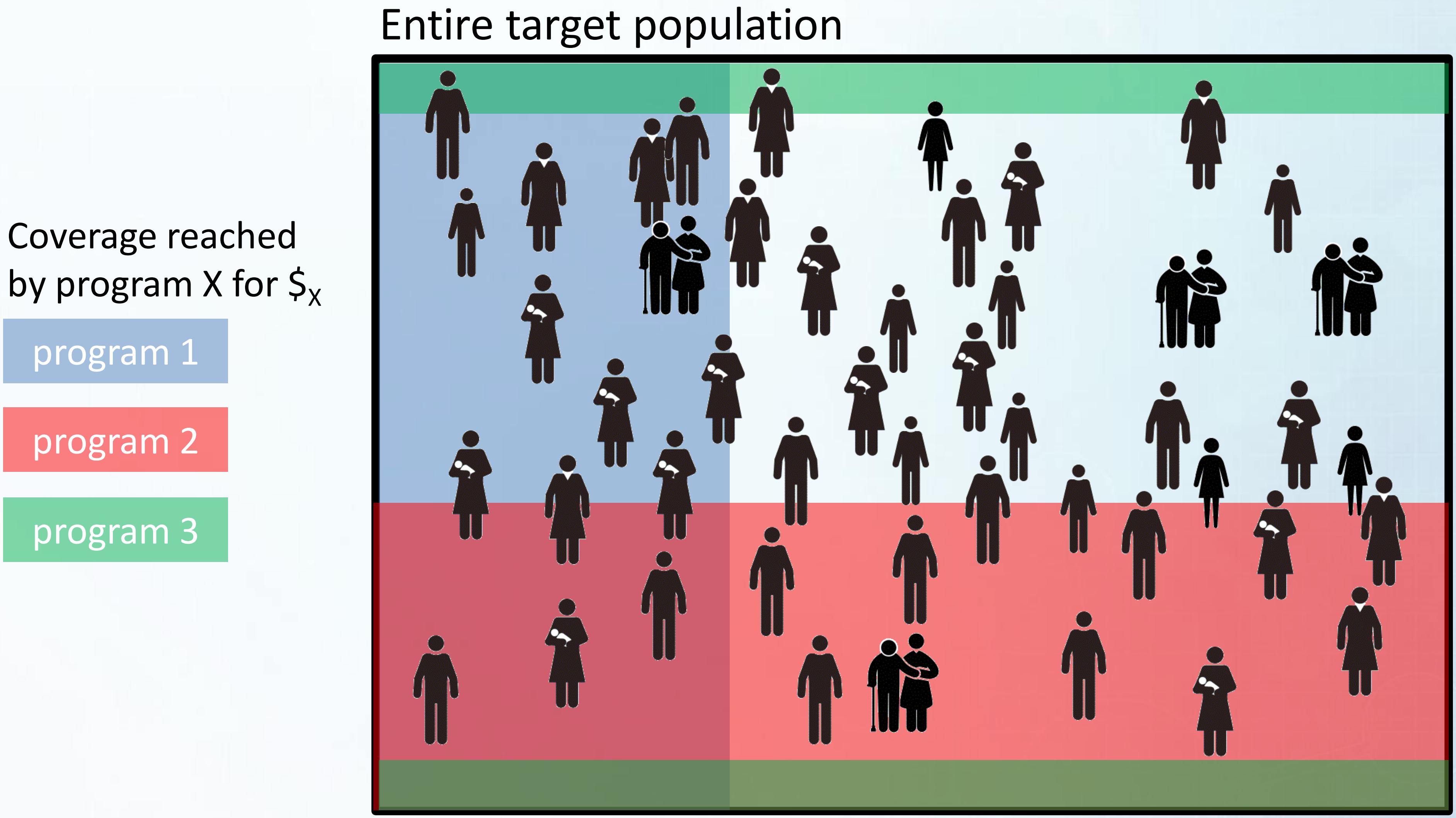
program 1

program 2

program 3

For every parameter, type of program interaction is set

Option 2: **random** (default)



For every parameter, type of program interaction is set

Option 3: **nested** (optional)

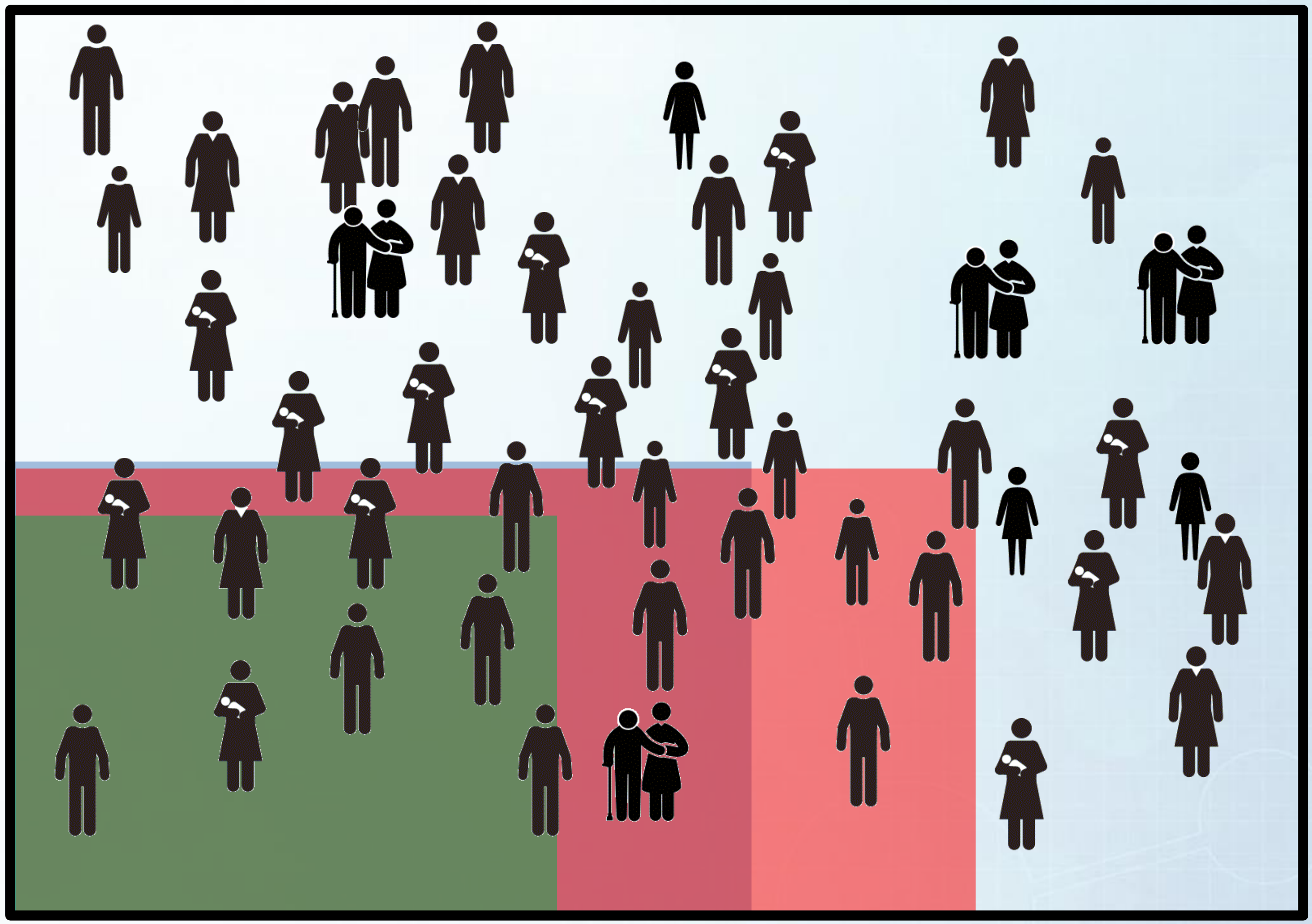
Coverage reached by program X for $\$_X$

program 1

program 2

program 3

Entire target population



Reconciliation – a critical step before running analyses

From the Cost functions, Summary tab, match the calibration and coverage values (within +/-10% as a guide):

Define cost functions | Define outcome functions | **Summary**

Year: 2018

Parameter	Population	Calibration value	Coverage value
Condom use for commercial acts	["Clients","FSW"]	0.6900	0.6847
Condom use for commercial acts	["MSM","FSW"]	0.3925	0.3730
Number of people on treatment	tot	700,000.0000	697,668.1332
Number of people on PMTCT	tot	75,165.0000	75,182.2664
Condom use for casual acts	["Clients","Females 20-24"]	0.3755	0.3497
Condom use for casual acts	["Clients","Females 25-49"]	0.3645	0.3497
Condom use for casual acts	["MSM","MSM"]	0.3000	0.2876
Condom use for casual acts	["Males 10-19","Females 10-19"]	0.3965	0.3830
Condom use for casual acts	["Males 10-19","Females 20-24"]	0.4400	0.4079
Condom use for casual acts	["Males 10-19","Females 25-49"]	0.4290	0.3996

Currency

- Suggested **currency** (for consistency across projects): United States Dollars (USD)

- **Any** currency can be used - inform modelling team of currency chosen and ensure the same currency is consistently used across the entire project

- Model does *not apply* inflation or discounting
  - These adjustments to spending output can be made outside the model

Optima HIV scenario analyses

Scenario analysis in Optima HIV

Asking **WHAT** if?

You can use scenario analysis to:

- Explore the impact of past spending
- Compare the impact of theoretical changes to the epidemic
- Compare the impact of different program assumptions
- Compare different model assumptions
- Many other factors can be examined using scenario analysis

And much more.

Budget and coverage scenarios

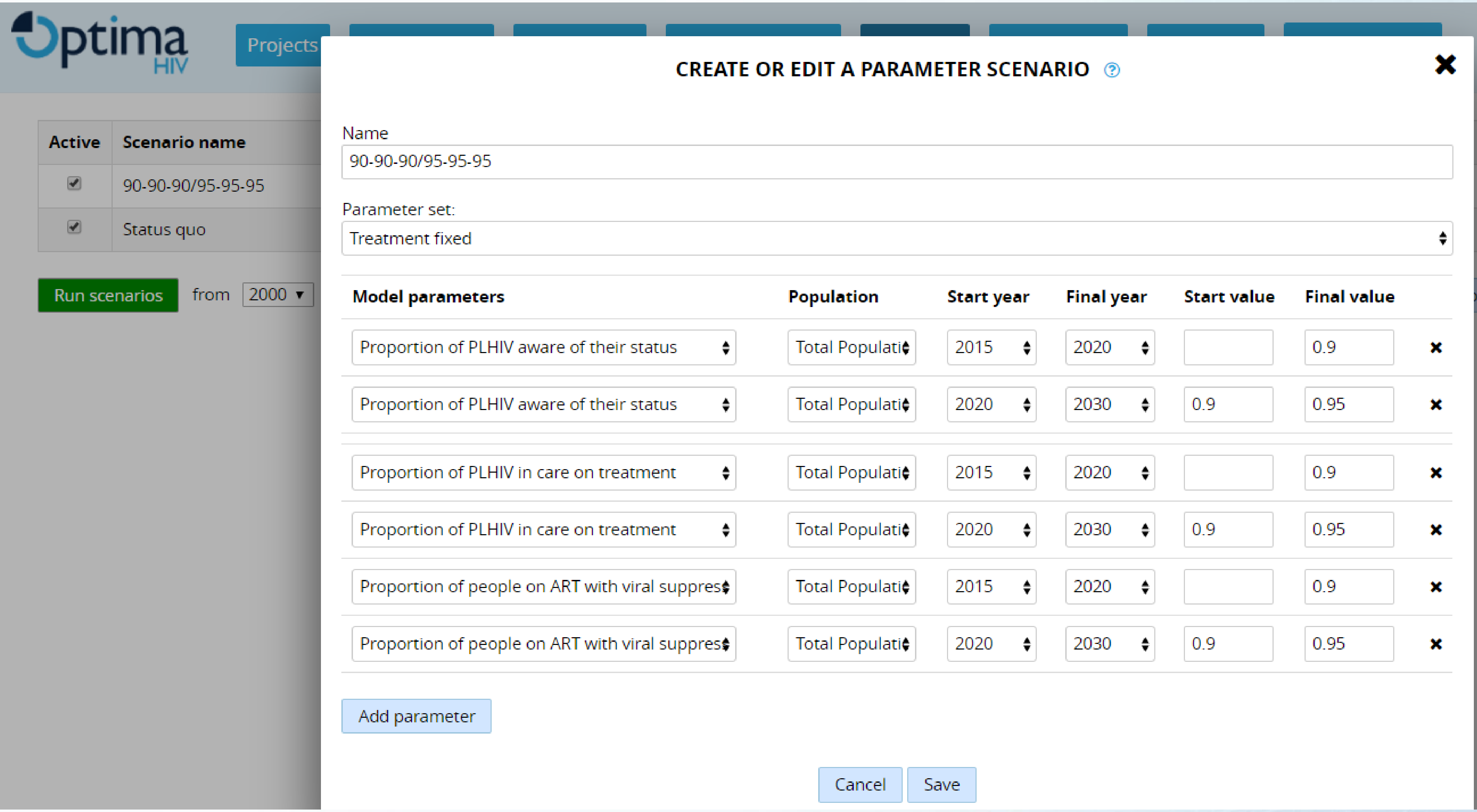
- Specify spending or coverage amounts for each program within the scenario (compared to baseline "business as usual")

- Results can be used to inform **policy analyses**

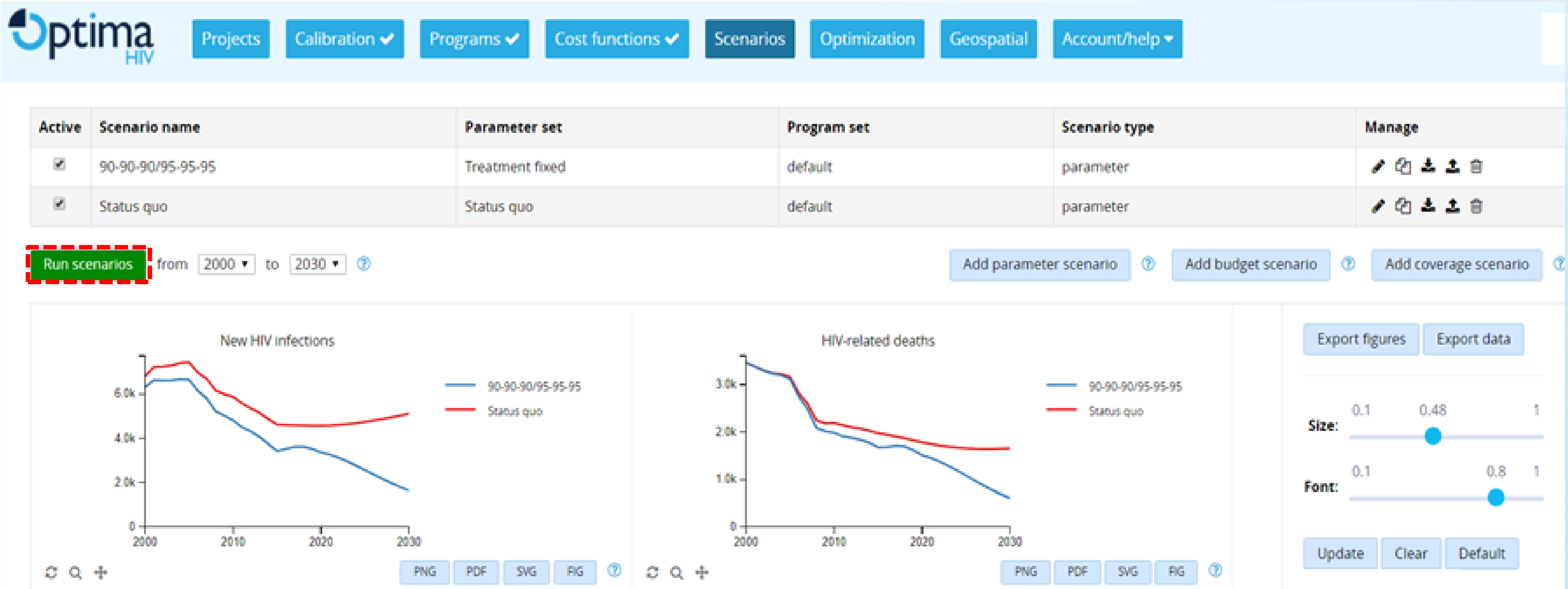
Active	Scenario name	Parameter set	Program set	Scenario type	Manage
✔	90-90-90/95-95-95	Treatment fixed	default	parameter	
✔	Status quo	Status quo	default	parameter	

Run scenarios from 2000 ▾ to 2030 ▾ ⓘ Add parameter scenario ⓘ Add budget scenario ⓘ Add coverage scenario ⓘ

Setting up a scenario analysis in Optima HIV



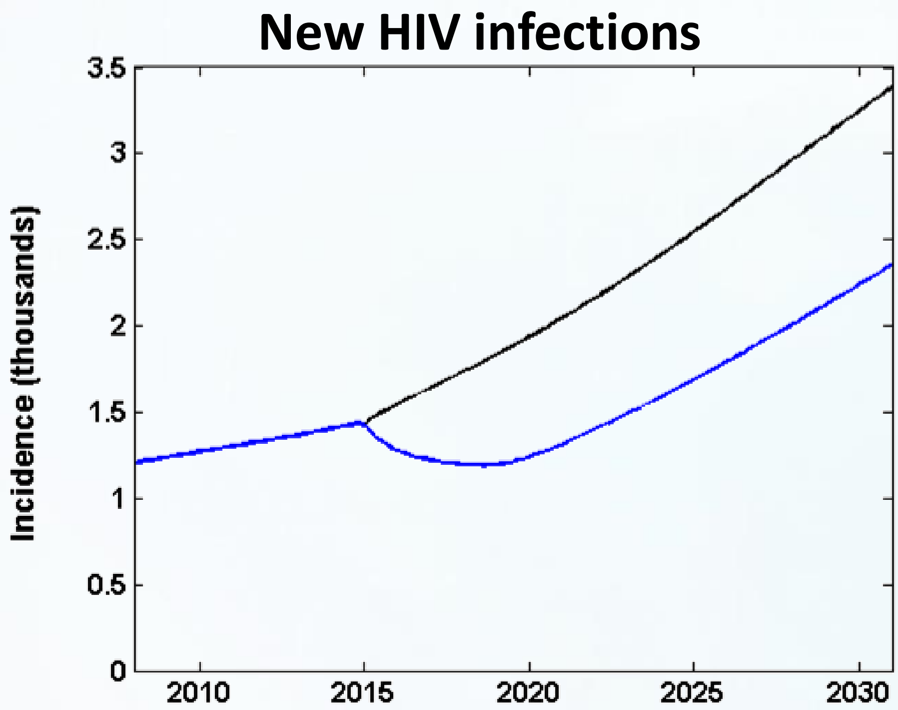
Run a scenario in Optima HIV

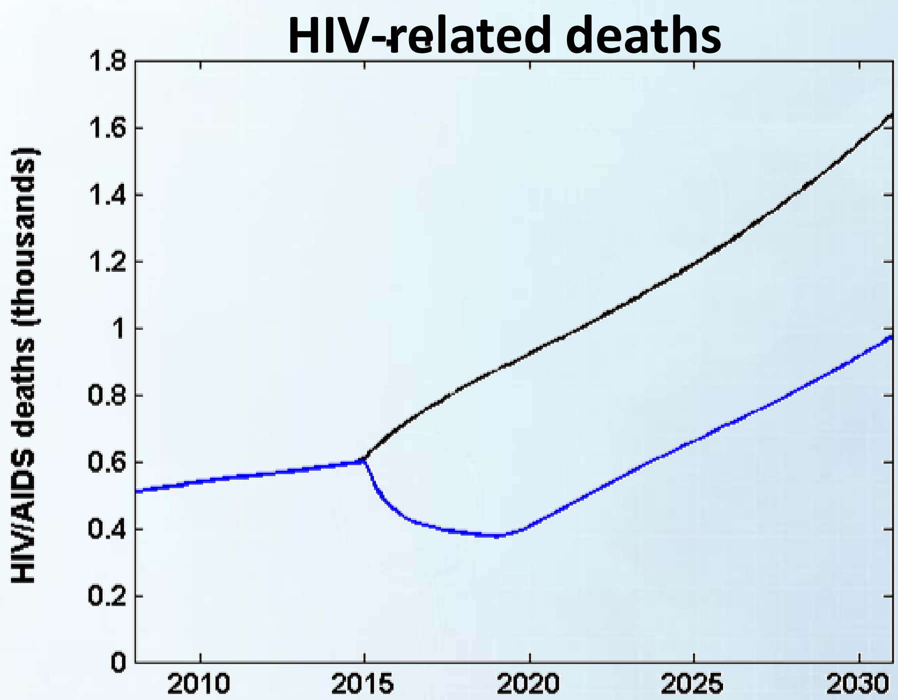


Exporting figures

Modeling impact of HIV test and treat strategy in Moldova

- Scenario to establish the effect of a test and treat approach:
  - Eligible to begin treatment regardless of CD4 count



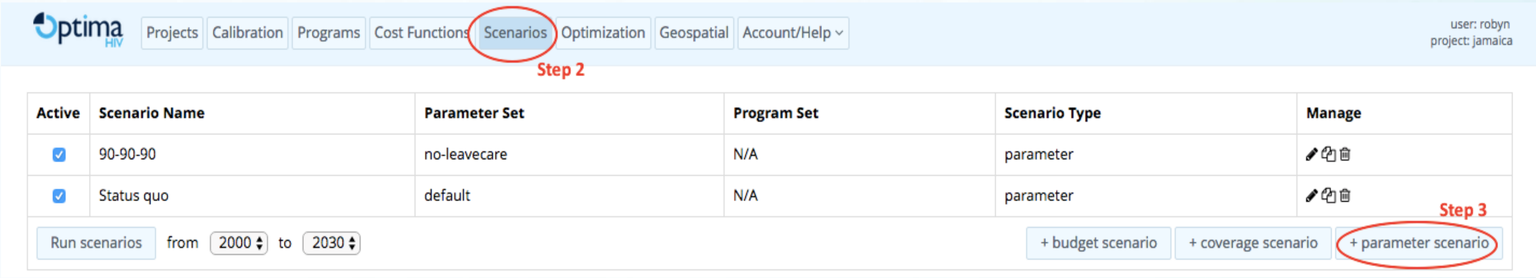


Test & Treat (defined as 70-90-90)

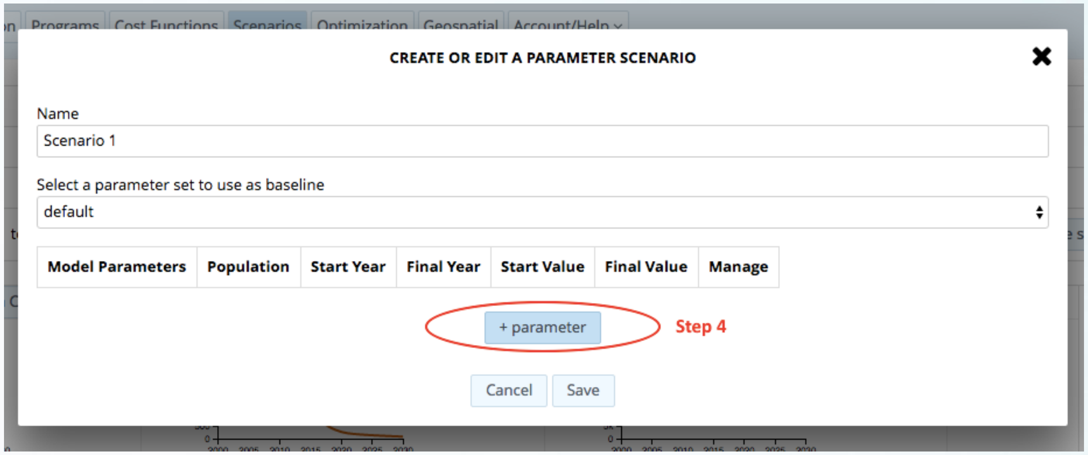
Maintain 2014 coverage-level of ART

Example: Analysis on the impact of PrEP for FSW

1. Log in with your provided account details
2. Navigate to "Scenarios" using the top navigation buttons (Screenshot 1)
3. Click the "+ parameter scenario" button

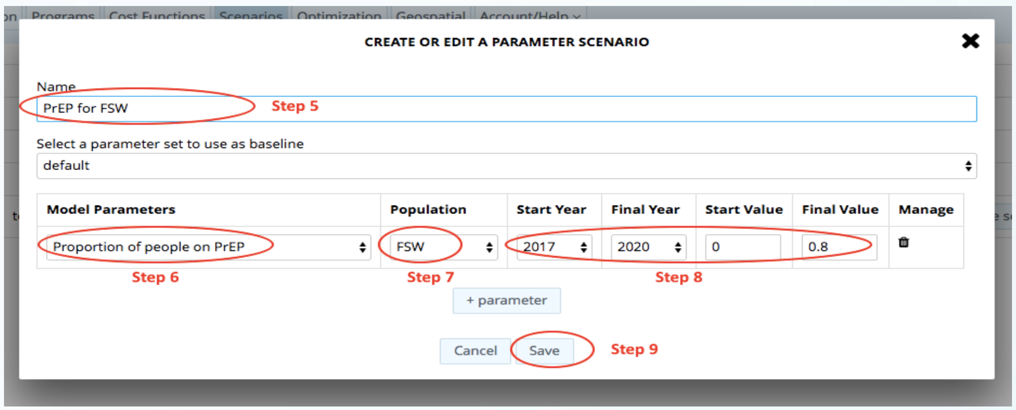


4. A pop-up window will appear. In this window, click the "+ parameter" button (Screenshot 2)

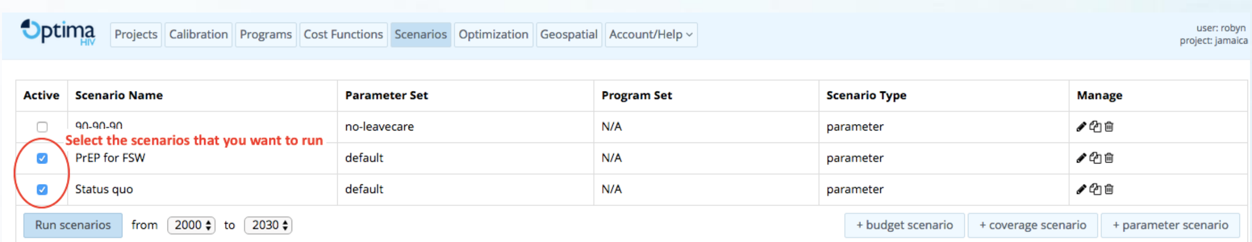


Example: Analysis on the impact of PrEP for FSW

5. Give the scenario a descriptive name, e.g. “PrEP for FSW”
6. From the drop-down list of parameters, select “Proportion of people on PrEP”
   From the drop-down list of populations, select “FSW”
7. Select the year that you want to begin the scenario (e.g. 2017) and the year that you want the scenario to end, and enter a number into the box “Final value”.
8. Save



9. Ensure that you have selected “Status quo” in addition to your new scenario “PrEP for FSW”, and click “Run scenarios” (Screenshot 4).

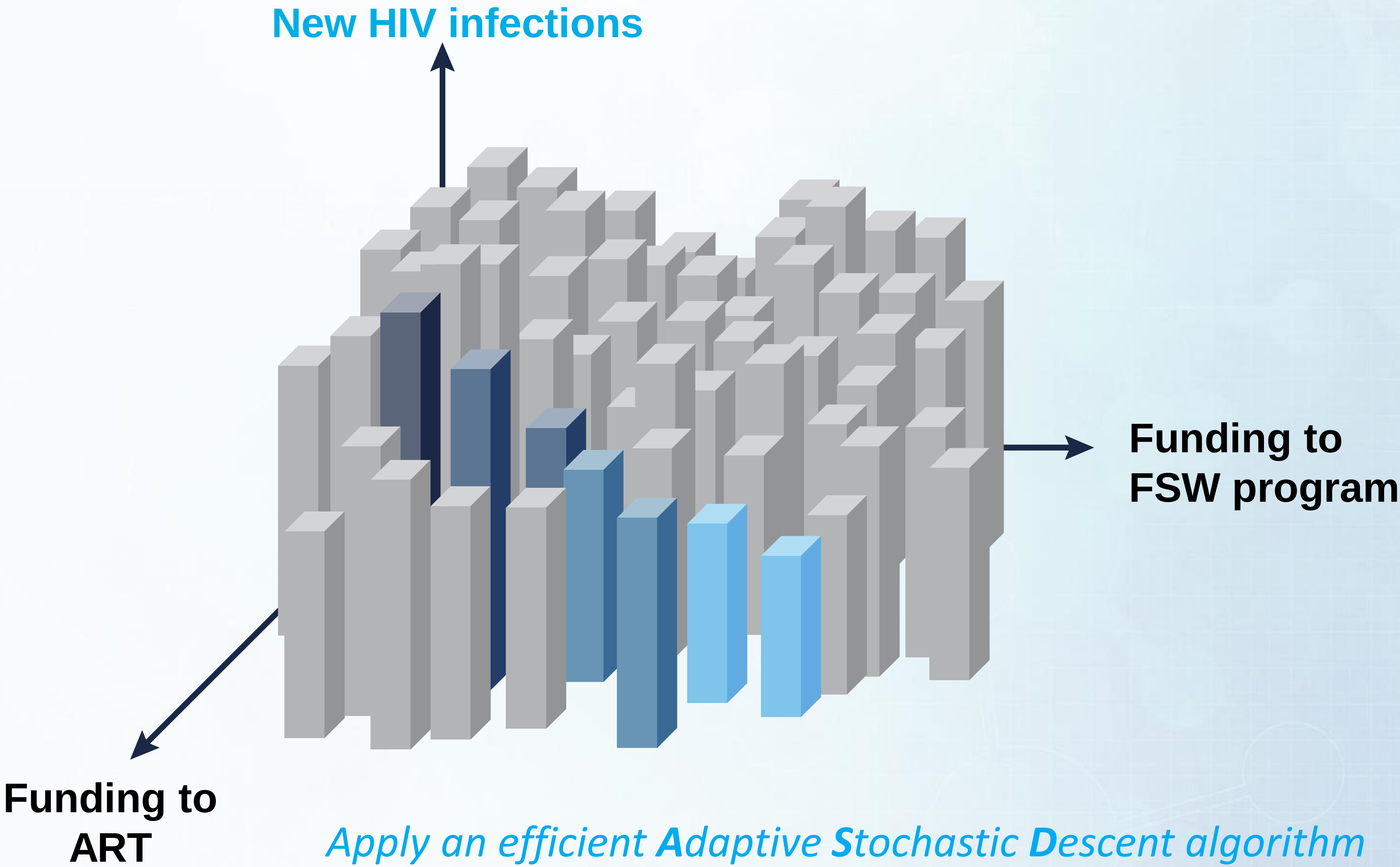


Optima HIV optimization analyses

Optimize resource allocation to best meet objectives

How should the budget be allocated amongst these ‘n’ programs, modalities, and delivery options, considering their interactions with synergies and limitations?

Optimization: **consider just two dimensions**

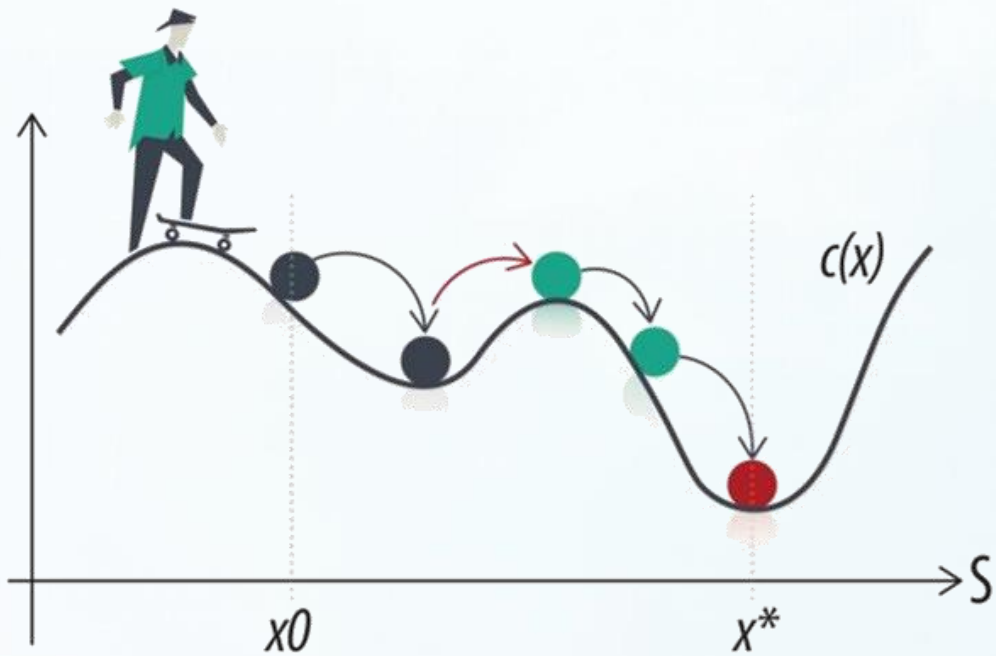


Apply an efficient ***A****daptive* ***S****tochastic* ***D****escent algorithm*

Source: Kerr et al 2016

Which optimization algorithm?

Traditional algorithms (e.g., simulated annealing) require many function evaluations—**slow**

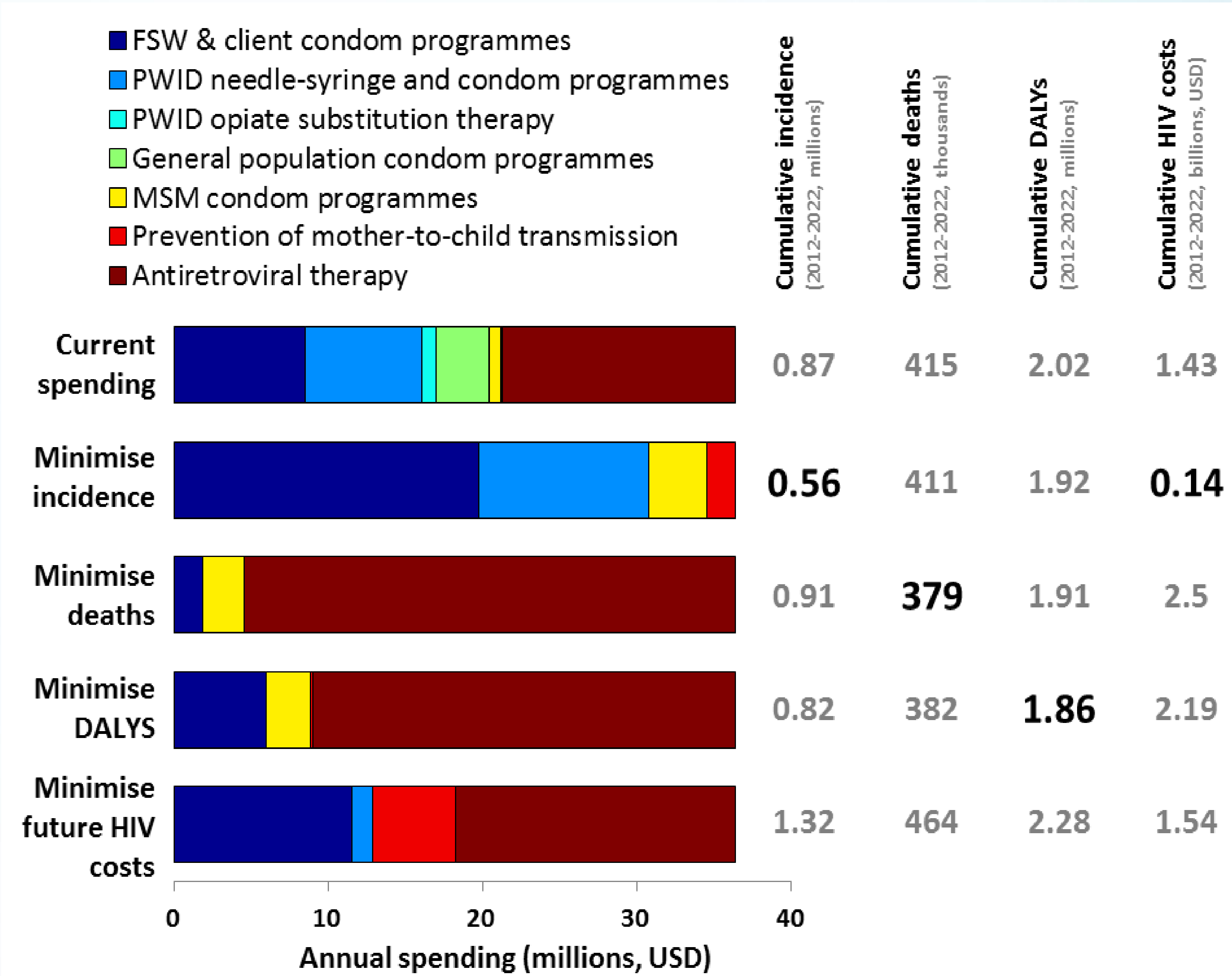


Optima's optimization algorithm

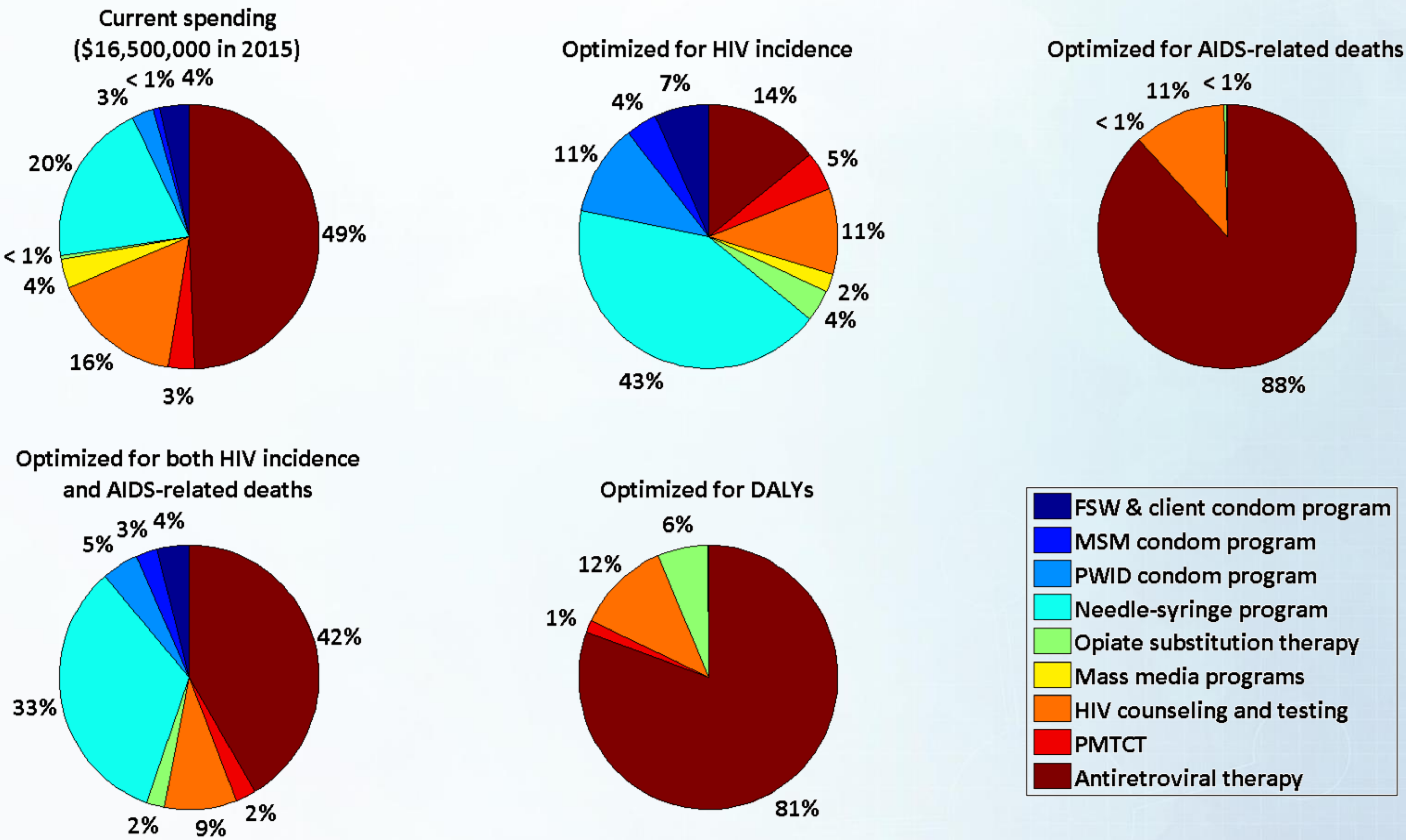
Adaptive **s**tochastic **d**escent

- **Adaptive:** learns probabilities and step sizes
- **Stochastic:** chooses next parameter to vary at random
- **Descent:** only accepts downhill steps

Different outcomes lead to different results

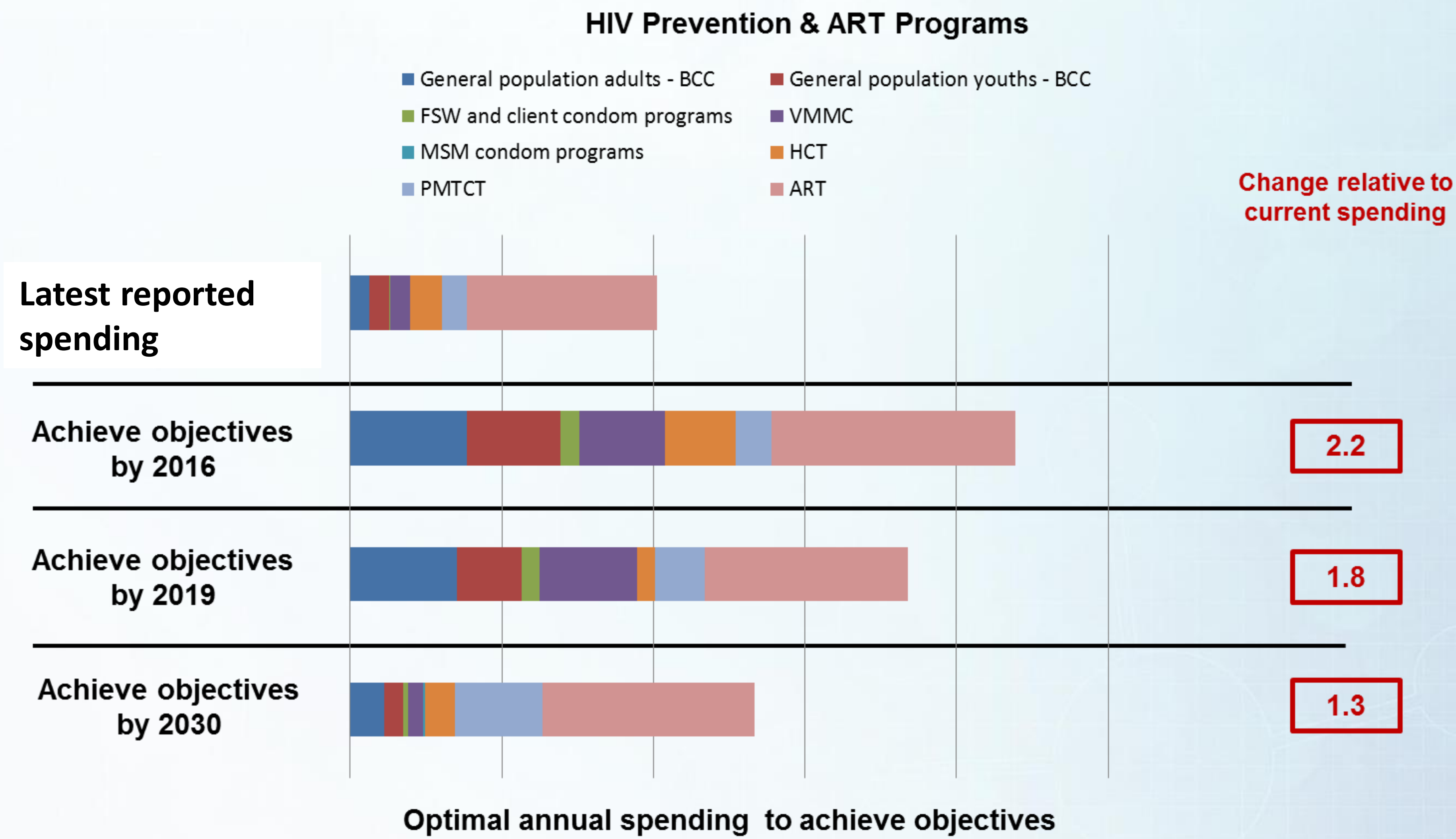


Example: Optima HIV optimization Kazakhstan

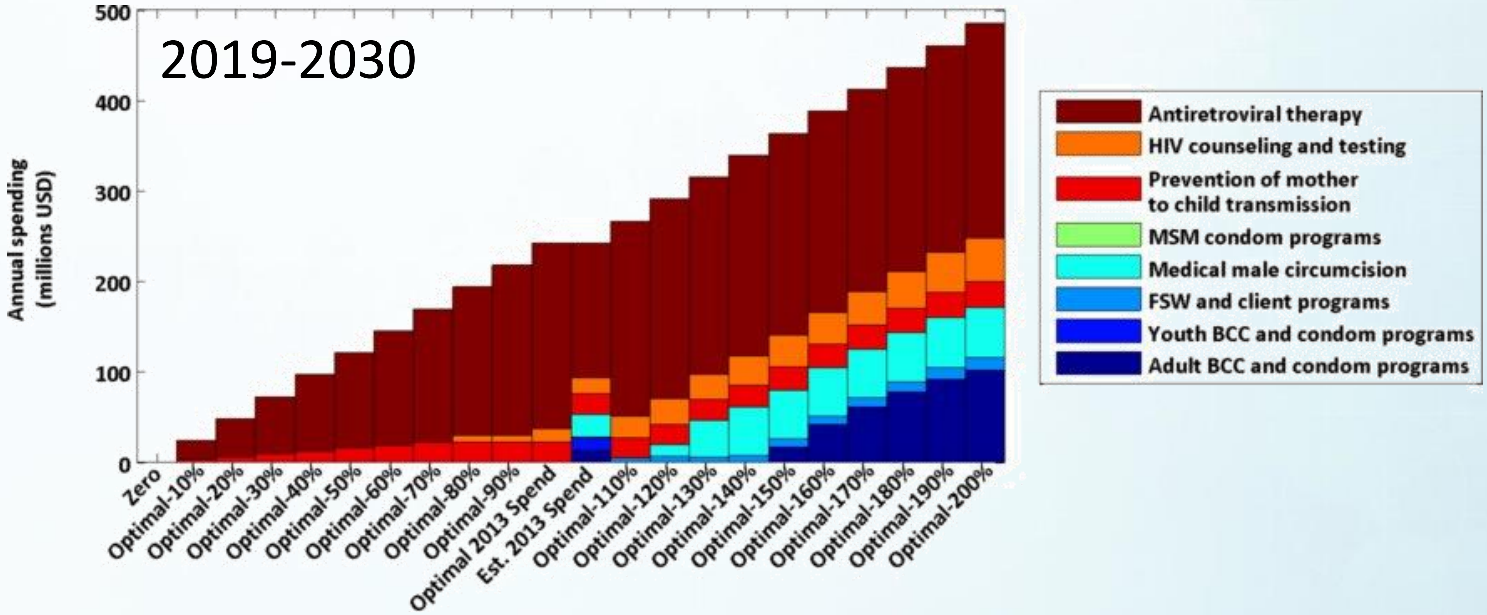


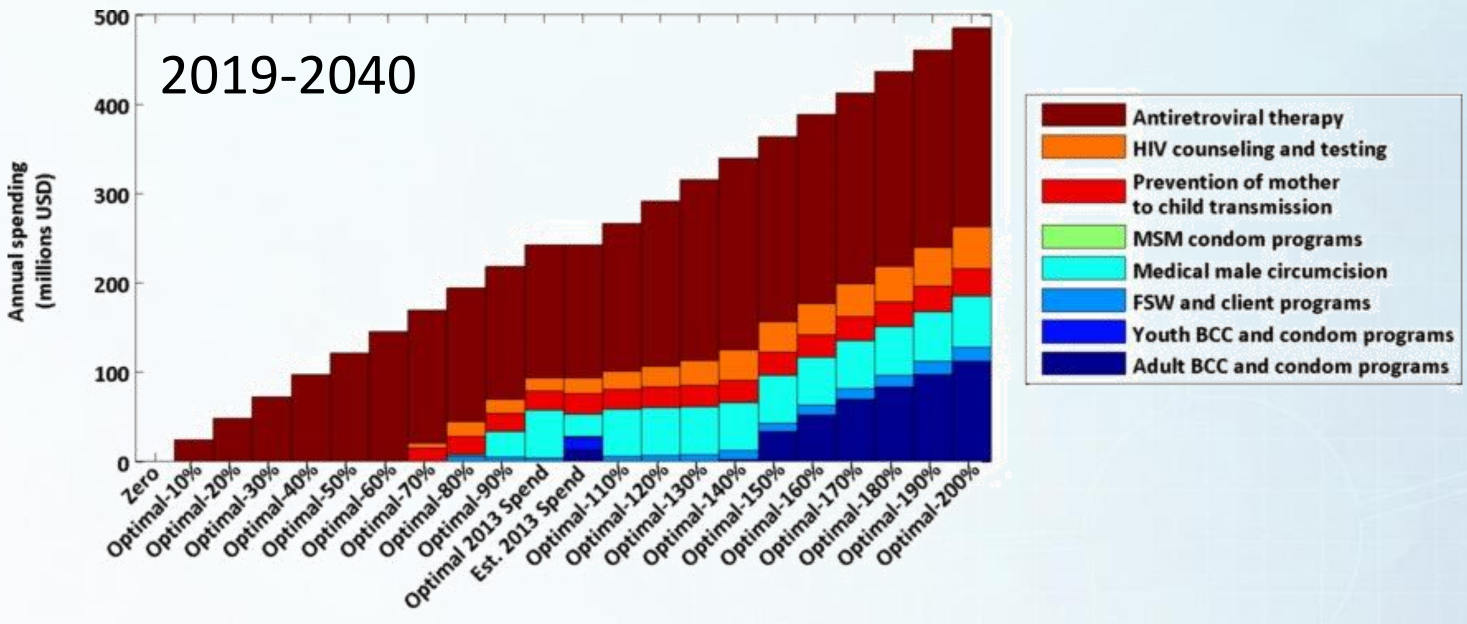
Time horizons matter

The greatest long-term impacts are affected by different short-term allocations



Time horizons matter





Objectives: achieving maximum impact

What objective is desired?

- *Minimizing new HIV infections*
  – Funding allocated to most effective HIV prevention interventions
- Minimizing HIV-related deaths
  – All funding would go to saving lives (treatment/care) for a short time horizon
- Maximizing HIV-related DALYs averted
- Maximizing HIV-related QALYs gained

- Minimizing longer-term financial commitments
- Obtain equality in access or impact across groups

Multiple objectives

- National strategic plans can have multiple objectives to be achieved by end of the National Strategic Plan (NSP) timeframe

  - For example, by 2022:
    - 60% reduction in HIV incidence compared with 2010
    - 50% reduction in HIV-related deaths compared with 2010
    - Virtual elimination of mother-to-child transmission
    - Attain universal treatment coverage

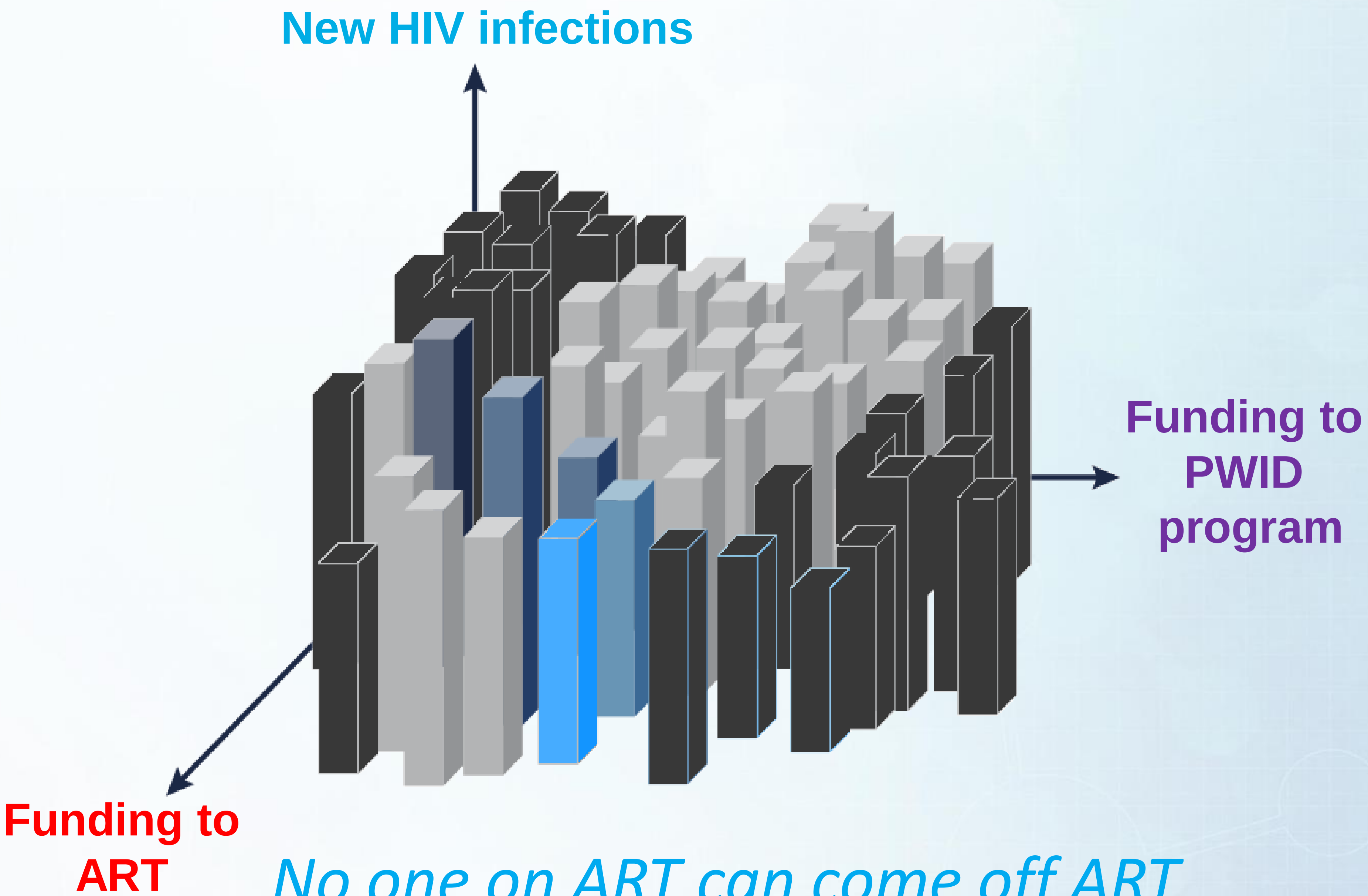
- Simultaneously get as close as possible to all NSP targets with the available funding

Recommendation: single objective to ease interpretation

- Recommend selecting a single objective with multiple outcomes
  - Identify allocation to minimize new HIV **infections**
  - Identify allocation to minimize HIV-related **deaths**
  - Identify allocation to minimize HIV-related **DALYs**

- Highlight or present the optimal allocation for a single objective for a single outcome, e.g. by 2030 reduce HIV incidence by 90% compared with 2010 (end AIDS target)

Constraints: ethical, economic, logistic, political

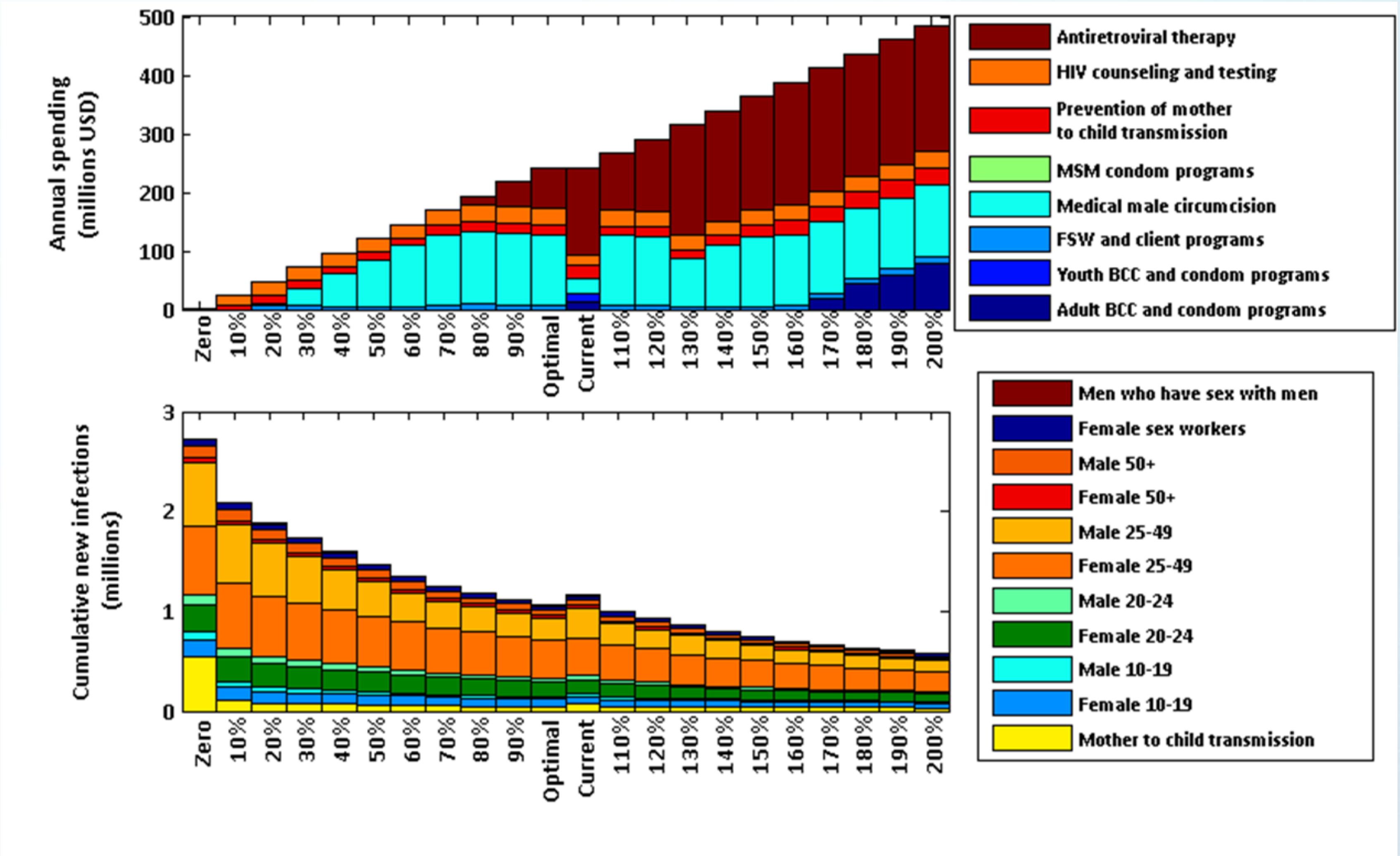


No one on ART can come off ART

Constraints are important, but should be limited

No constraints

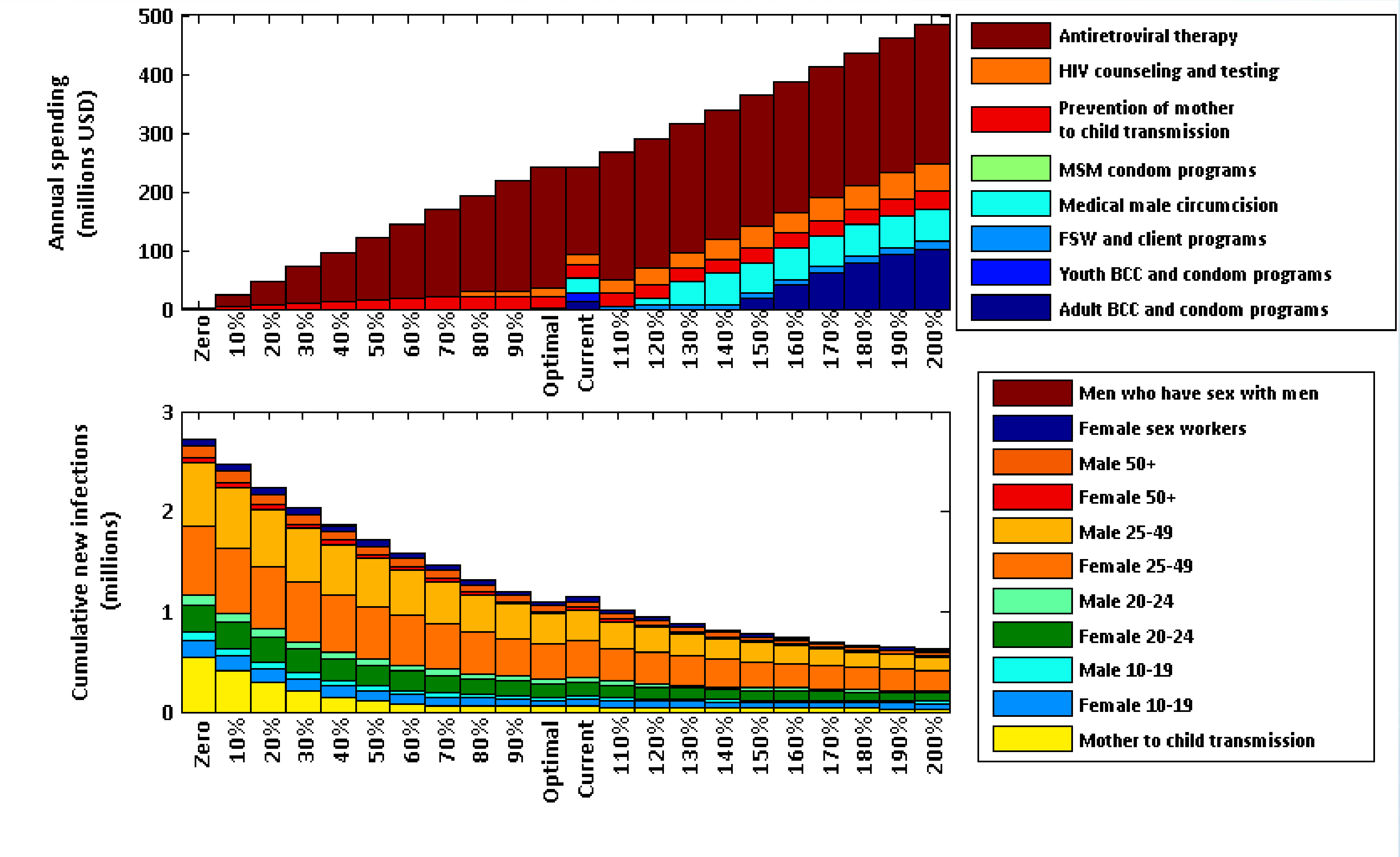
Objective: to minimize new HIV infections



Constraints are important, but should be limited

With constraint

No one on treatment should be removed from treatment, unless by natural attrition (ie, death)



Constraints are important, but should be limited

Most commonly requested constraints:

- No one on **ART** should be removed from ART
- **PMTCT** is important to constrain so it cannot be defunded
- **OST** has many important multi-sectoral benefits and funding should not be decreased
- Programs cannot be scaled up faster than 20% per year
- Programs should not lose more than 30% funding per year in a scale-down period
- Important to maintain some prevention for all populations
- Non-targeted HIV program spending cannot be touched and are not considered within the optimization
  - Cannot easily measure direct impact on HIV status, need evidence
- Maintain some funding for programs targeting key populations

Constraints are important, but should be limited

- If all commonly requested constraints were incorporated, there would be limited or no change in funding allocation
  - Little to no change towards achieving the objective

- **Recommendations**
  - Analyses be as unconstrained as possible
  - No one on treatment be removed from treatment (ART, PMTCT, OST)
  - Add constraints around funding mechanisms
    - Donor-based program targeting policies
  - Reasonable scale-up/down periods (with allowance for as large changes as possible)

Setting up optimization in Optima HIV including constraints